This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE CENTRAL TIAN-SHAN MOUNTAINS

MERZBACHER

Digitized by Google

3/6

Digitized by Google

Digitized by Google

18/5/39

Digitized by Google

AN EXPEDITION INTO THE CENTRAL TIAN-SHAN MOUNTAINS

CARRIED OUT IN THE YEARS 1902-1903

Digitized by Google

Digitized by Google

Digitized by Google

KHAN-TENGRI (ABOUT 23,600 FT.), TAKEN FROM A POINT (ABOUT 15,000 FT.) ON ITS BASE ON THE UPPER INYLCHEK GLACIER (MUCH FORESHORTENED). SOUTHERN AND SOUTH-WESTERN SLOPE.

(*Frontispiece.*

Digitized by Google

THE CENTRAL TIAN-SHAN MOUNTAINS

1902-1903

BY DR. GOTTFRIED MERZBACHER

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1904

Digitized by Google

Digitized by Google

THE CENTRAL TIAN-SHAN MOUNTAINS

1902-1903

BY DR. GOTTFRIED MERZBACHER

PUBLISHED UNDER THE AUTHORITY OF THE ROYAL GEOGRAPHICAL SOCIETY

UNIV OF CALIFORNIA

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1905

Digitized by Google

DC793
E2H5

PRINTED BY
HAZELL, WATSON AND VINEY, LD.,
LONDON AND AYLESBURY.

Digitized by Google

CONTENTS

PAGE

INTRODUCTION 1

CHAPTER I

FROM PRZHEVALSK TO NARYNKOL AND THROUGH THE MUKUR-MUTU VALLEYS 10

CHAPTER II

THE VALLEY OF BAYUMKOL 19

CHAPTER III

THE SARY-JASS VALLEY AND THE SEMENOFF GLACIER . 36

CHAPTER IV

TO THE INYLCHEK GLACIER AND FARTHER SOUTH . . 60

CHAPTER V

FROM THE KAPKAK VALLEY TO THE GREAT MUSART VALLEY 76

CHAPTER VI

NORTHERN MUSART VALLEY, MUSART PASS, AND SOUTHERN MUSART VALLEY 82

CHAPTER VII

FROM THE MUSART VALLEY TO KASHGAR 99

M42035

Digitized by Google

CHAPTER VIII

PAGE

EXCURSIONS ON THE SOUTHERN EDGE OF TIAN-SHAN TO COLLECT PALAEONTOLOGICAL MATERIALS . . . 103

CHAPTER IX

THE SOUTHERN MARGIN OF TIAN-SHAN BETWEEN KASHGAR AND UCH-TURFAN 111

CHAPTER X

TO THE KHALYK-TAU AND BACK TO UCH-TURFAN . . 126

CHAPTER XI

THE SOUTHERN TRANSVERSE VALLEYS—THE ALLEGED AND THE ACTUAL BREACH, FORCED BY THE NORTHERN WATERS 139

CHAPTER XII

THE SABAVCHY GLACIER 151

CHAPTER XIII

THE KUKURTUK VALLEY 158

CHAPTER XIV

FROM THE KUKURTUK VALLEY TO THE BEDEL VALLEY AND OVER THE BEDEL PASS TO THE NORTH . . 166

CHAPTER XV

THE WATERSHED BETWEEN NARYN AND SARY-JASS AND THE PASSAGE OF THE SOUKA PASS TO LAKE ISSYK KUL . 176

CHAPTER XVI

SURVEYING ON THE SEMENOFF AND MUSHKETOFF GLACIERS 185

CHAPTER XVII

SECOND VISIT TO THE INYLCHEK GLACIER, AND DISCOVERY OF THE TRUE POSITION OF KHAN-TENGRI . . . 193

Digitized by Google

CHAPTER XVIII

PAGE
OVER THE ACHAILO PASS TO THE KAYNDY GLACIER . . 217

CHAPTER XIX

FROM THE KAYNDY VALLEY OVER THE UCH-SHAT PLATEAU TO THE KOI-KAF 225

CHAPTER XX

THROUGH THE KAYNDY VALLEY TO THE SARY-JASS AND INYLCHEK AND BACK TO THE TEKES 237

CHAPTER XXI

TO THE BAYUMKOL AGAIN AND THEN TO THE LITTLE MUSART VALLEY 245

CHAPTER XXII

VISIT TO SOME ALPINE LAKES 254

CHAPTER XXIII

THE DONDUKOL VALLEY AND THE NORTHERN MUSART VALLEY AGAIN 263

CHAPTER XXIV

OVER THE TEMURLIK-TAU TO KULJA 272

CHAPTER XXV

SUMMARY 276

NOTES CONCERNING THE MAP 283

INDEX 287

Digitized by Google

Digitized by Google

LIST OF ILLUSTRATIONS

KHAN-TENGRI, SOUTHERN AND SOUTH-WESTERN SLOPE	*Frontispiece*
	Facing page
TELEPHOTOGRAPHIC VIEW OF KHAN-TENGRI	26
THE "MARBLE WALL," OR PEAK NICHOLAS MIKHAILOVICH	28
TELEPHOTOGRAPHIC VIEW OF THE SUMMIT OF KHAN-TENGRI	52
TELEPHOTOGRAPHIC VIEW OF KULU-TAU	62
VIEW FROM A PLATEAU BETWEEN THE SARY-JASS AND TYS-ASHU VALLEYS	64
PEAK IN THE SOUTHERN BORDER-RANGE OF THE INYLCHEK VALLEY	66
JIPARLIK GLACIER	90
IN THE UPPER TEREK VALLEY (KHALYK-TAU)	134
PEAK EAST OF JANART PASS	142
EASTERN MARGIN OF JANART PASS	144
ISSUE OF KUM-ARYK FROM ITS GORGE	148
SABAVCHY GLACIER, DEBOUCHING OF A LATERAL GLACIER FROM NORTH-EAST	156
MOUNT CATHERINE, IN THE BORKOLDAI RANGE	176
CHAIN BORDERING MUSHKETOFF GLACIER ON ITS SOUTH	190
LAKE KARA-KUL-SAY	198
PARTING OF INYLCHEK GLACIER	198
SUMMIT OF KHAN-TENGRI, NORTH-WESTERN SLOPE	222
HEAD OF KAYNDY GLACIER	222
VIEW TO THE HEAD OF SAIKAL VALLEY, FROM A RIDGE IN THE EASTERN BAYUMKOL GLACIER	246

Digitized by Google

Digitized by Google

AN EXPEDITION INTO THE CENTRAL TIAN-SHAN, IN THE YEARS 1902 AND 1903

UNIV. OF CALIFORNIA

PRELIMINARY NARRATIVE

INTRODUCTION

When in 1892, on a journey into Central Asia, I first made acquaintance with a small portion of the Central Tian-Shan, I received, even by a mere flying visit, abiding impressions of its magnificent mountain chains. Later on, these impressions were renewed through reading the masterly descriptions of the celebrated Tian-Shan pioneer, P. P. Semenoff, and through study of the reports of his successors, N. A. Severzoff and J. W. Mushketoff, who have earned for themselves high honour by their researches. The desire was accordingly kindled in me to gain more accurate insight into the highest regions of this mountain chain and its glaciers, and also to contribute somewhat to their exploration.

Extensive travels, however, in other mountain

Digitized by Google

lands and labours of large compass in other fields barred the way for ten years to the gratification of my desire. At length in January, 1902, during my stay in the Russian capital, the initiatory steps were taken. There, encouraged by the assured support of the Imperial Russian Geographical Society, especially its President, his Imperial Highness the Grand Duke Nicholas Mikhailovich, and its Acting President, Senator P. P. Semenoff, I determined to start that year on my travels into the Tian-Shan. Semenoff's valued counsels and the study of the rich Russian literature on that mountain chain, handed over to me most obligingly by the Secretary of the Imperial Russian Geographical Society, Prof. Grigorieff, confirmed me in my opinion that one summer would not suffice for the accomplishment of any substantial result in the high regions of the Central Tian-Shan, so extensive and so difficult of access, but that, first and foremost, experience would have to be gathered respecting the technical difficulties, awaiting the explorer in ice-and-snow regions of quite a unique type. From the first, therefore, I was resolved to devote at least two years to the enterprise.

Our knowledge of the orographical and geological structure and of the flora and fauna of the Tian-Shan has been enriched by many eminent Russian explorers. Its highest regions, however, buried in snow and ice, had hitherto remained but very imperfectly known. A more thorough exploration was needed to answer the many

Digitized by Google

questions, respecting the structure of the central parts, which a glance into the existing maps at once called forth, and to throw light on many dark points in the later history of the mighty configuration of the chain. Our knowledge, again, of the glaciers of Central Tian-Shan has been greatly increased, more particularly by the explorations of A. W. von Kaulbars, and by the expedition of I. W. Ignatieff and A. M. Krassnoff, fraught in many respects as it was with important results. There still, however, remained much, particularly in respect of the largest glaciers, craving elucidation. In order to explore extensive glacier regions and their environment, and to unravel the complex structure of the parts not easily surveyable, it is necessary to follow up the glacier valleys to their head and to climb peaks of great elevation with a view to obtaining a comprehensive plan and orientation. For such a task three prime requisites were wanting to my predecessors: practice, experience, and outfit. It seemed to me therefore imperative to enlist "Alpinism" in the service of geographical science in the Tian-Shan, in accordance with the example of so many travellers of brilliant accomplishment in other regions of lofty mountains. I accordingly invited to join me in my enterprise one of the best approved of modern Alpinists, the engineer Hans Pfann, of Munich, a truly valuable aid, and further engaged a young and vigorous Tyrolese mountain guide, to whom, the following year, was added a second guide.

Digitized by Google

By way of special provision for the geological service of the expedition, and with a view to amassing a palæontological collection, I secured the assistance of a young and energetic geologist, not to be daunted by difficulties in the ground to be surmounted. Prof. Steinmann, of Freiburg, Baden, was good enough to recommend to me one of his pupils and assistants, the young geologist Herr Hans Keidel, who on my invitation joined the expedition. With the trusty support of such assistants I might hope to obtain some data of value in the service of science.

Unfortunately the time assigned to the preparation of an undertaking of such compass, extending over so long a period, for procuring and testing the indispensable instruments, apparatus, and manifold outfit, was all too scantily allotted. Only by dint of feverish exertion and the active help of self-sacrificing friends, among whom I will name only the celebrated mountain photographer, Cavaliere Vittorio Sella of Biella and the Caucasian explorer, M. von Déchy in Odessa, was the expedition for 1902 set on foot in tolerable time, though, indeed, several weeks later than desirable.

In this report, written in Tashkent, immediately after the return of the expedition from the mountains,[1] it is of course impossible for me to

[1] This report was despatched from Tashkent on April 18th, 1904, long before the publication of the narratives of Dr. Friedrichsen ("Forschungsreisen in den Central Tian-schan u. Dsungarischen Ala-tau": *Mittheilungen der Geographischen Gesellschaft* in Hamburg, Bd. XX. August 1904) and Sigr. Giulio Brocherel ("In Asia

Digitized by Google

render an exact account of all the work done throughout this long and toilsome journey, or to communicate all the observations of scientific interest. The purpose of this report is rather to give particulars of the itinerary of the expedition and a general narrative of its experiences, especially those new or hitherto unknown. The more elaborate digest, embodying comprehensive deductions, must be reserved to a later date after the rich collections, amassed by the expedition, have been scientifically examined and arranged; this latter task will, however, presumably claim a lengthened period of time. Accordingly, the more detailed report of the journey, for which Herr Keidel has undertaken the elaboration of the geological and geotectonic part, can hardly be published till a somewhat remote date. It seemed therefore advisable to give in the preliminary report rather more than a bare enumeration of data and to render it at least a provisional picture of the districts traversed. In this report I have endeavoured more particularly to embody observations on the present and past glacier conditions of the Tian-Shan and on peculiarities in the physical features of its valley

Centrale": *Bollettino della Società Geografica Italiana*: July 1904), when I had not the slightest knowledge of the results of the former or even of the routes followed by the Italian expedition. Hence no reference to either publication will be found in the present report, the appearance of which would have been too long delayed, had I attempted to incorporate comparative notes after my return. Moreover, I was quite unaware, when writing my report, that several valleys and localities, to which I had every reason to suppose mine to be the first visit, had been previously reached by the Italian expedition.

Digitized by Google

formations; subjects to which, throughout the expedition, my attention was specially directed. On the other hand, in order not to give to the report a compass which would retard its publication, botanical, zoological, and climatological observations will have to be almost wholly omitted.

The quoted figures incorporated in the report will of course be taken as of only approximate validity, and are stated in round numbers, seeing it will require some considerable time till the different calculations in question have been completed. The various heights given will be accepted as having only at most an approximate validity relatively to one another.

On May 15th I left Munich, accompanied by Herren Hans Pfann and Hans Keidel, joined at Vienna by the previously engaged mountain guide, Franz Kostner, of Corvara; we thence repaired to Odessa, whither had been despatched the larger part of the luggage. Here we were detained a few days in complying with the Custom-house formalities and taking over the provisions of conserves, biscuit, etc., which, thanks to friendly assistance, were already awaiting us. Owing to the fact that the Imperial Russian Ministry of Finance had obligingly granted free entry to my outfit, instruments, apparatus, etc., the transactions with the Custom-house were rapidly settled. The stay, moreover, in Odessa till the departure of the steamer was made grateful to us by the amiable hospitalities of the noted explorer, M. von Déchy, and of the Crimea-Caucasian Mountain

Digitized by Google

Club and its most courteous and helpful President, Prof. Ilovaisky.

On May 25th we landed at Batum, and thence proceeded to Tiflis, where we were again delayed a few days. There I received maps, most kindly left for me by the chief of the Topographical Department of the Ordnance staff in St. Petersburg, Lieut.-General von Stubendorf. There, too, all my instruments were retested at the Observatory.

At Tiflis I had the high honour of a reception from the President of the Imperial Russian Geographical Society, his Imperial Highness the Grand Duke Nicholas Mikhailovich. As his Imperial Highness had in Petersburg facilitated for me the introductory steps to the expedition, he took a warm interest also in its development and assured me of his further assistance.

After being joined at Tiflis by the Preparator, E. Russel, of Piatigorsk, the expedition next proceeded, *viâ* Baku, to Krasnovodsk, and then, by the Trans-Caspian railway, to Tashkent. There, in consequence of letters of recommendation from the Imperial Russian Ministry of Foreign Affairs and War, and thanks to the letter of accreditation of the Imperial Russian Geographical Society, I met with the friendliest reception from his Excellency the Governor-General of Turkestan, Lieut.-General Ivanoff. In the most handsome manner official papers were given me, ensuring me the support of all authorities in the Russian lands to be traversed by me.

Seeing the expedition was to extend over two

Digitized by Google

years, the provisions and materials of different kinds had to be divided, and the part intended for the second year packed and forwarded to Kashgar. Thanks to the active support of my revered friend Herr R. Schubert in Tashkent, this and other affairs were happily disposed of. On June 9th, therefore, the expedition of five persons, now heavily encumbered with luggage, was enabled to enter on its lumbering tarantass-passage through the Central Asiatic steppes.

While I was on my way alone from Pishpek, which I left on June 18th, to Vernoie, there to present myself to the District Governor of Semirechensk, his Excellency Lieut.-General Ionoff, and to receive from him special letters of introduction to the authorities under his administration, Herren Pfann and Keidel made an excursion to the Alexander Mountains, climbing one of the highest peaks. Meanwhile, under charge of Kostner and Russel, the heavy luggage was farther carried by Dunganian carters to Przhevalsk. On June 24th I rejoined my fellow-travellers in Tokmak, whence our march lay along the north bank of Lake Issyk Kul to Przhevalsk. There I had the pleasure of encountering the expedition of Prof. Saposhnikoff, of Tomsk, and its members, among them Dr. M. Friedrichsen, of Hamburg. Friendly greetings were exchanged. At first I was under some apprehensions, lest the Russian expedition and mine might clash in their respective routes through the high mountains—a contretemps which in the

Digitized by Google

interest of science would be all the more regrettable, inasmuch as in the extensive and little-explored Tian-Shan there was ample room for the exploratory enterprise of more than one expedition. At once Prof. Saposhnikoff frankly communicated to me his programme, and we found that our routes would only cross each other in the Sary-jass valley at the foot of the Semenoff glacier. As, moreover, the Russian expedition had assigned to that strip of the mountain chain no more than a few days—quite insufficient for a thorough exploration of the Semenoff glacier, included as an essential item in my programme—my apprehensions were happily shown to be groundless.

Digitized by Google

CHAPTER I

FROM PRZHEVALSK TO NARYNKOL AND THROUGH THE MUKUR-MUTU VALLEYS

A SERIOUS drawback to the progress of our expedition was the delay for nearly a week of the arrival of our luggage at Przhevalsk. Not till July 2nd was our advance by the San-tash pass to Karkara begun. In crossing the pass (7,200 ft.; 2,155 m.) made known to the world by Semenoff and Serverzoff, we had the opportunity of gathering in our first carboniferous fossils in the Tian-Shan. On the descent of the pass, which leads through extensive tertiary deposits, one comes up on the first indications of glacier formation in this region: porphyry granite and syenite blocks transported thither by ice from the heights of Kungeu and Kuuluk-Tau. Soon after, on the descent from the tertiary sandstone heights at Taldy-bulak, the wide, green-mantled, ancient lake-floor of Karkara (6,000 ft.) is seen below, encompassed on the south by a long, many-peaked, calcareous chain (Bash-ogly-tagh), bearing on it small glaciers, and towering above the lake-floor to a height of 4,500 ft. (1,200 m.). On its

Digitized by Google

margin the ancient lake-terraces are in good preservation.

On the north and north-west the wide basin is enclosed by low, flat tertiary ridges, offshoots of the Chul-adyr, behind which crop up here and there the much more considerable heights of Ketmen-Tau. On the south-west edge of the basin, in these tertiary deposits, considered hitherto deprived of fossils, Herr Keidel had the rare good fortune to collect a small fauna, which may prove of great importance for the determination of a part at least of these tertiary deposits.

Alpine meadows, dressed in flora of surpassing beauty, adorn the wide, high-lying floor, strewn with débris. In its midst there rises up every year, from May to October, a spacious town of metal houses and wooden booths—the famous yearly market, that is of such great importance to the extraordinarily numerous Kirghiz population of the Tekes, Chalkody-su, Kegen, and Charyn region. Thousands of Kirghiz tents collect in a wide circle around the wooden town. This is the mart where the Kirghiz exchange their products of wool, hides, sheep, and horses for the manufactured goods, exposed for sale by dealers mostly of Tartar race. Here, in a secluded green Alpine bottom, completely withdrawn from the highways of the world, walled in by mountain chains glittering in glacier snow, the traveller may admire a lively tumult of business and contemplate modes of commerce, belonging to an epoch of

Digitized by Google

culture, unknown for centuries past in Europe. Here he may study scenes of a picturesque charm, not to be easily surpassed anywhere else. During the four months of the yearly market the seat of the administrative authorities of the regions in question is transferred to this spot. It thus happened that the head of the Narynkol district, J. I. Likhanoff, on whom depended the future fate of the expedition, had his official seat at this odd market-town. Here the greater part of the riding- and packhorses, as also the saddles, covers, headgear, etc., appertaining thereto, had to be bought. Here, too, a number of Kirghiz "Jigits" (troops serving for escort) familiar with the mountain routes and some porters from the discharged Narynkol Kossacks had to be engaged. The safe transport of later supplies of provisions to the high mountain regions and many other matters had to be settled. Thanks to the energetic support of Herr Likhanoff, these affairs were satisfactorily disposed of in a few days.

On July 7th I was able to continue my march to the Kossack village of Narynkol (Okhotnichi). The way thither leads from the luxuriant grass-plains of the ancient lake-basin, over the adjacent undulating high plains, into a spacious green landscape, the configuration of which is throughout due to former ice-action. The peaks of the long, much curved mountain chains, Bash-ogly-tagh and Kapyl-Tau, shooting up in the south are intersected by wide, trough-shaped, high-lying valleys, each of which is occupied by a small

Digitized by Google

field of nevé and a small glacier. As may be distinctly perceived, these are only the remains of former ice-currents of considerable extent, the course of which may be satisfactorily traced by the ground, lateral and terminal moraines remaining intact and now coated over with vegetation. All superficial forms, characteristic of a landscape vacated by the ice, even drumlins, may here be observed. On a second visit to this district, the way led me into a larger lateral valley (Bash-kara-bulak), where I had the opportunity of more closely examining these typical forms of a vanished glacial epoch, and to follow them into the cauldron-shaped hollows of the mountain chain, where great masses of glacier snow once rested.

Beyond Sary-jass-tuty station you leave the river-bed of the Chalkody-su, and, crossing the mountain chain through the glen of Tute, enter the uppermost valley of the Tekes. On the way the traveller, viewing the circular wall of the mountain chain, is already impressed by a feature characteristic of the Central Asiatic mountains and especially the Tian-Shan. The mouths of the great transverse valleys of older origin are always wide and their floor at the same level as that of the principal valley. This is due to the enormous amount of débris piled on the latter in a region poorly drained, and covering the base of the margin of the mountain chain.

The farther march to Narynkol is confined almost entirely to the region of the tertiary

Digitized by Google

formation and of the younger river and lake deposits. Only a stage distant, however, in the above-mentioned glen of Tute, you cross a zone of quartz-porphyries and hornblend-porphyries, at the foot of which lie the tertiary deposits.

On July 9th the expedition entered Staniza Narynkol (6,200 ft.; 1,760 m.), lying near the northern foot of the first lower chain of the Central Tian-Shan, hard by the Chinese frontier. This place served for a length of time as headquarters for the explorations in the high mountains. Seeing our arrival took place three weeks later than had been planned, there was no time to lose if any results were yet to be harvested in what was left of the short summer.

Herr Keidel took in hand the investigation of the tertiary formation of the Tekes plain, and of the carboniferous limestones, towering up behind it. On July 10th I made my first mountain excursion, and, with Herr Pfann, the Tyrolese Kostner, and a Kossack from the Tekes valley, rode some twenty versts (thirteen English miles) down to the mouth of a transverse valley, cutting in a southward direction into the mountain chain, a valley known by the name of Mukur-mutu. Between the great transverse valleys of the Great and the Little Musart rivers, which, in an approximately southern course, cut into its northern slope, the great chain is again divided, principally by three short transverse valleys, filled with exceedingly dense pine-forest—the Mukur-mutu valleys—

Digitized by Google

which, after short courses, terminate in an extensive high plateau region. The Kalmuck population of the Tekes valley understand in general, under the name of the Mukur-mutu, the whole slope of the mountain chain between Little and Great Musart with all the transverse valleys, intersecting it. According to this acceptation, Mukur-mutu would therefore designate the region which to the east and the west of the great valleys named is bounded on the south and south-east by the valleys of Maralty and Dondukol, and on the south-west by Uertenty valley: valleys of which, later on, there will be much to say. The district is known by the name also of Kutingy. I was here able at once to assure myself that the delineation of the whole of this strip of land in the forty-verst map does not suggest even a remote idea of the reality. Of the Mukur-mutu valleys, for example, only one is shown, and that, too, just three times longer than its actual course. In the high plateau region in which the Mukur-mutu valleys originate erosion has caused only broad channels of little depth. The many-peaked chains, walling in the head waters of all above-mentioned valleys, form likewise the verge of the plateau mass, which on its turn swells up into some dome-shaped heights. By the forty-verst map it looks, as though Khan-Tengri towered up here in the southern enclosing wall of the plateau, and to make sure of the fact was the motive to this excursion. We wandered but a short distance through the most western of the Mukur-mutu valleys—their mouth about

Digitized by Google

6,400 ft. (1,850 m.) high—and soon turning sharp eastwards, we made a very steep climb over slopes wooded and carpeted with Alpine meadows of unsurpassable luxuriance, displaying a marvellous Alpine flora over old ground moraine-deposits. After some time craggy ranges of slabby rose-coloured granite break through the steep, abraded beds of schist and the soft forms of the green-clad diluvial deposits covering them, and you mount to a stage of the plateau, where we encamped at a height of about 7,700 ft. Thence we turned southward and ascended to a far higher stage of the plateau, and there soon reached a zone of dark, richly fossiliferous, dense limestones. Without undergoing a high degree of crystallisation, these limestones, along with the stratified granites cropping up between them, have been subjected to enormous pressure, so that most of the organic inclusions were crushed beyond identification and also transformed into silicates, of which, too, but very little is to be obtained. The booty gathered was therefore small. On a second visit. the following year, to the valley, we were fortunate enough to pick up, at another spot, a somewhat better collection, from which the age of the limestones was determined to be lower carboniferous. These dense, dark limestones alternate with light-coloured and somewhat granular calcareous slates, and, farther on, with red argillaceous-calcareous slates. The whole series follows the dip of the granites (average direction N. by 35° E.), which in their turn, follow, farther to the south-east, on

Digitized by Google

the limestones. The series varies in its course, however, very much, and higher up, passes into an almost opposite direction. There you find yourself in a region of dislocation. A beautiful cauldron caused by subsidence, with a little lake at its bottom, still lies on the boundary between the granites and limestones in this latter formation. Higher up, a part of the calcareous mass, composing the plateau seems to have subsided to a considerable length, in a southward direction towards a trenchlike depression, the axis of which, directed east-south-east, is the axis followed by the high valley of Maralty, cutting transversely through the plateau. A more detailed description of this interesting region would exceed the limits of this preliminary report. Be it only added that the spot where the better preserved fossils are to be found, lies exactly in a plain of fracture.

We mounted one of the highest dome-shaped protuberances of the plateau (about 11,000 ft.; 3,400 m.), there photographed the magnificent peaks of the Uertenty valley, and took telephotographic views of the high-peaked, ice-covered chain which is planted in front of and parallel to the main ridge here trending east-south-east. Of this main ridge only a few elevations could be seen, towering up behind the parallel chain. Did Khan-Tengri rise at the spot, where in the forty-verst map and in all other maps, it is represented, its pyramid must inevitably have been seen from our standpoint. All we learned by our excursion was therefore only

Digitized by Google

the confirmation of the opinion, previously suggested, namely, that in this cardinal point the maps were all of them at fault. The task therefore devolved on us to determine the actual situation of Khan-Tengri.

Digitized by Google

CHAPTER II

THE VALLEY OF BAYUMKOL

THE first advance made towards the solution of this problem led us into the large transverse valley of Bayumkol (wrongly named by some travellers Karakol and Biankol). The axial direction of this valley, some forty miles long, changes many times from the spot, where the river bursts forth from the mountain chain; the valley cleaves its way through the high land in an approximately southern direction, but afterwards bends round to the south-east, then to the east-south-east. It next again takes a southern direction and, at its termination, bifurcates into two branches; one trending south and south-west, the other south-east, both of them occupied by considerable glaciers and surrounded by chains wholly covered with glaciers. The peaks of these chains are among the highest of the Central Tian-Shan, rising to 20,000 ft. and more. These chains form part of the central watershed of the Tian-Shan. The river, rushing in large volume down the valley, takes, on issuing from the mountains into the vast basin-shaped expansion of the Tekes valley, at first an eastern direction, flowing through the capacious basins of

Digitized by Google

two ancient border-lakes, once connected. Of one of these lakes of late tertiary age the margins, comprised of sandstones, sandy clay and slate beds, are in excellent preservation. The stream next strikes north-north-east by the Staniza Narynkol, and at last, taking a northerly course, reaches the Tekes. Our way, therefore, into the mountain valley led us through a depression beginning some twelve miles up the river. This depression, in the neighbourhood of the Staniza Narynkol, is marshy and hedged round by a broad belt of dense high-grown bush. In this thicket, through which our road led us, there were buzzing millions of gadflies. These set upon my horses, which had just been brought down from the cool mountain meadows, with such fierceness that, becoming restless, they displaced their burdens, and so, getting scared, some of them took to flight. In a twinkling the others all followed their example. In less than a minute all the twelve packhorses, throwing off their loads and dragging their girths after them, bolted in mad gallop in all directions all over the wide steppe and through its thickets, continually kicking at the packages with their hind legs. Instruments, apparatus, provisions—everything was flung to the winds. Speechless with horror, I looked on at the spectacle. Should the altogether indispensable articles of outfit, more particularly the instruments and apparatus, be smashed, many months would be needed to make up for the loss. The expedition would be wrecked at its threshold. The cases of a number of packages were burst open

Digitized by Google

under the horses' hoofs, and their contents, especially the boxes of preserves, flung higgledy-piggledy among the tall grass of the steppe. While some of the "Jigits" and Kossacks hurried after the runaway animals, the others searched among bush and grass for the packages. After a time it appeared that the scare was worse then the scath, and that I had got rather cheaply out of the disaster. The most valuable articles were found to be all of them undamaged. Help came from Narynkol, whither I had despatched a messenger. The horses were caught and brought back; the damaged cases, straps, etc. were hastily mended. After the loss of five hours the caravan was again ready for the march. It was some time, however, before I recovered from the shock.

So soon as the enclosed basin just mentioned, about four and half miles long, had been left in our rear by a narrow passage in its enclosing wall, we entered another basin, much more extensive still, whose northern environment is formed by a moderately high calcareous range. The tertiary lacustrean deposits of the enclosing wall of the basin we had just left are continued along the foot of the calcareous range in a series of terraces. In this calcareous wall, exactly opposite the mouth of the Bayumkol valley, and at the north end of the lake-basin, three and one-third miles broad, there is noticeable a gatelike breach, through which there now flows, in a straight course northwards to the Tekes, the inconsiderable streamlet

Digitized by Google

Ukurchy. On the other hand, instead of continuing its northern course, to which in the wide plain there is no opposing obstacle, and thereby reaching the rocky gate in the north and so making a direct passage to the Tekes, the Bayumkol river, on issuing from the mountain chain, all at once bends to the east. It thereupon forthwith encounters a calcareous cliff, Tas-tepe, barring its path, and which it is bound to break through. It has sawn out a deep bed in the calcareous rocks at the edge of the mountain chain in order to be able to continue its farther course east, north-east, and north, till at last it reaches the Tekes. What could induce the river to make this complicated journey? Evidently in former times it had taken a straight course to the north across the plain and through the breach, which it had once itself effected. This continued to be its course till in the ice age either masses of ice or boulder-deposits blocked the passage and compelled it to take an eastern course. To the importance of the former glacier age the ancient masses of moraines lying on the skirts of the mountain ranges in the Tekes valley give testimony. In their form and arrangement I was able to read that the ice masses in the past, pushed forward from the mountain chain, had flooded the crest of the first border chain. The mouth of the Bayumkol valley is about four-fifths of a mile wide; the bottom lies at the same level (*vide* p. 13) with that of the principal valley (about 7,000 ft.), and, owing to the

Digitized by Google

enormous masses of deposit, piled on the ancient floor, it rises at a quite moderate incline (about 174 ft. per mile). The valley spreads into basins as much as a mile in width, and separated from one another by contractions of no more than 1,100 ft. Most of these expansions contained lakes, dammed by the ancient terminal moraines, which, in the period of the successive retreat of the earlier glacier, got thrown up, one behind the other. Only in the case of two of these expansions could I make out other causes for their origin. One, near the mouth of the valley of the Ak-kul, has without doubt been formed, or at least developed, by lateral erosion of the valley river. Another, at the mouth of the lateral valley Tyr-asha, arose in consequence of a fault between limestones and chloritic slates.

Of most of the ancient terminal moraines, only inconsiderable remains are preserved. Only two of them still block up the valley as enormous walls. One is at the mouth of the lateral valley of Alai-aigyr, which, running eastwards, affords access to the Saikal valley (Little Musart). The other is at the mouth of the Kenem-begu valley, which leads west to a col, giving access into the Ashu-tyr valley. Both moraines, each of them over the third of a mile broad, owe their preservation to mighty mountain-slips, rolled down and covering to a great extent the moraine walls, one of the mountain-slips being of granite, the other of phyllitic rock. Where these vast masses of

Digitized by Google

blocks rest, atmospheric influences and the strength of waters, endeavouring to clear away the morainic walls were spent in vain. The river was obliged to force a passage at both places in a deep ravinelike glen, where, to all appearance, it resumed and deepened the bed it had occupied before the ice age. Besides these two monumental witnesses to the once mighty glacier conditions of the valley, evidence to the same fact is to be found also in the form of high-lying polished rocks and in the heaps of moraine débris or terraces of glacial rubble along the walls of the valley, preserved everywhere, where the slope is not too steep. These débris heaps form high terraces many miles wide, now on the right, now on the left bank. In many places moraine débris may be seen towering more than 800 ft. above the level of the river. At the mouths of many lateral valleys, especially that of the Ashutyr valley, the moraine walls of very considerable magnitude, formed of the débris, are in excellent preservation, at the mouths of others they have got washed away and shifted.

At the entrance of the Bayumkol valley the enclosing walls are formed of granite, to which, a little higher up, succeed fossiliferous limestones and calcareous slates, as well as dark argillaceous slates, to which, in turn, again granite succeeds. Granites of very various character, limestones, calcareous slates, argillaceous slates, also gneiss and other crystalline slates, alternate along the whole length of the valley in unintermittent

Digitized by Google

sequence and in very peculiar conditions of stratification. Into this matter, however, there is the less need to enter here, as Herr Keidel has taken a geological profile of the valley, which he will publish and elucidate in the geological part of the more complete report. I may, however, here call attention to the fact, that granite and gneiss take the prominent part in the structure of the enclosing walls, that the sedimentary matter always reappears, pressed between the granites, without, however, showing any sign of contact-metamorphosis, and that the granites appear to have been vehemently ground. This points to folding processes which have affected both kinds of rocks in common. We further note the embedding of diabasic rocks, more especially diabasic slates. Lastly, here too attention must be drawn to the important fact, first established in the Bayumkol valley and since confirmed in all the Tian-Shan valleys, leading to the principal ridge, which were visited by the expedition—the fact, namely, that in every case the crystalline rocks reach no farther than proximity, nearer or more remote, to the main watershed. This latter is itself built up exclusively of sedimentary rocks, which have undergone transformation through dynamo-metamorphic processes, in part also in consequence of the eruption of diabasic rock. In the structure of the most central and highest region of the Central Tian-Shan, not only limestones of different kinds have taken part, but also dense, dark, argillaceous

Digitized by Google

slates of very various formation, dark slates, having the character of roofing-slate, preponderating, and marbles of different colours, mostly white, grey or with light streaks.

The valley presents the character of a northern Alpine valley, showing excellent Alpine meadows and extensive and very dense pine forest (*Picea Shrenkeana*), with which are here and there combined deciduous trees, such as sorbus, willow, cornus, mountain ash. The somewhat auriferous alluvium of the river was, more than forty-five years ago, when the district still belonged to China, exploited by the Chinese. Later, the attempts to find gold were prosecuted with the aid of extensive plant by Russian speculators. It would appear, however, that they did not pay, seeing the constructions are no longer worked and are fallen into decay.

The river carries an uncommon volume of water, and, in the warm hours of the day, rushes in raging flood down its bed. It is therefore dangerous to cross, as I learned to my cost. One of the packhorses, slipping, was at once carried away into a whirlpool, whence it was rescued only with the greatest exertion. Of its load a package was lost, containing all my personal belongings.

Just before reaching the mouth of the side valley of Ashu-tyr, and behind a belt of wood which stretches diagonally across the main valley, the magnificent pyramid of Khan-Tengri suddenly comes into view. The mountain looks so near

Digitized by Google

TELEPHOTOGRAPHIC VIEW OF KHAN-TENGRI (ABOUT 23,600 FT.), TAKEN FROM NORTH, FROM THE MIDDLE COURSE OF THE BAYUMKOL VALLEY. DISTANCE ABOUT 24 MILES.

(*To face p.* 26.

Digitized by Google

UNIV. OF
CALIFORNIA

Digitized by Google

as to convey the illusive impression that it is planted in the background of the Bayumkol valley. Arriving at the end of the great granite rockslip, lying on the top of the first ancient terminal moraine at the débouchement of the lateral valley of Alai-aigyr, one sees, far below, the middle course of the Bayumkol valley as a forest-encircled basin with a quite level bottom; here, on the other hand, the view is magnificently closed by Khan-Tengri, and it seemed again as if at the end of the Bayumkol valley we should reach the foot of the giant mountain. There we found indeed the head of a valley, exhibiting magnificent glaciers and a circle of very high mountains clothed with ice from their feet to their summits, but Khan-Tengri was not among them. Owing to the fact that the mountain has no rival and overtops the highest summits of all the neighbouring ranges by over 8,000 ft., it can be identified from points of sufficient altitude and at sufficient distance in any direction whatever. The determination of its position, with a careful exploration and topographical survey of the Bayumkol glacier, and the geological investigation of the ranges bounding the valley, would shortly form our task.

Our camp was pitched at the end of the main valley at an altitude of about 10,500 ft. (3,200 m.), near the spot where the glacier arms, approaching one another from the south-east and south-west, unite in one common terminal tongue which ends about 10,660 ft. (3,250 m.) in altitude.

Digitized by Google

While the south-western glacier (the longer one) forms a rather compact, not very steeply inclined, ice-field, about eight miles (twelve versts) long, which has its origin between snow-clad peaks on a lofty snow-clad ridge (first trodden by me the following year), the south-eastern glacier is somewhat shorter, but much steeper and more rugged; it is formed by the union of three ice-streams which, breaking through gorges in the ice-clad ramparts of the valley, unite in a circus-shaped basin. On the surface of the ice a number of funnel-shaped lakes are hollowed out. The wide ice-basin is immediately overhung by a mountain which for height, massiveness, and boldness of form is the most commanding of the giant peaks which rise round the Bayumkol glacier. From its ice-clad shoulder on the north-west side a perpendicular wall about 6,500 ft. (2,000 m.) in height, on which, of course, neither snow nor ice can remain, falls straight to the rugged broken ice of the glacier-floor. This precipice is of white, grey and streaked marble, and for this reason we called the mountain the "Marble Wall" ('Marmorwand'). Like Khan-Tengri, this commanding mountain stands conspicuous as a landmark of the Central Tian-Shan, an orientation point. It can be recognised by its remarkable height and by the fact that it towers up just at the point of union of the main ridge with its branches, visible far and wide from every point on the high ground. Seen from the Tekes plain, it is known by its remarkable form and

Digitized by Google

THE "MARBLE WALL," OR PEAK NICHOLAS MIKHAILOVICH (ABOUT 21,000 FT.), TAKEN FROM A POINT (ABOUT 14,000 FT.) ON THE EASTERN BAYUMKOL GLACIER.

[*To face p.* 28.

Digitized by Google

Digitized by Google

its precipitous marble side. It was not till later that we proved what an important part it plays in the formation of the Tian-Shan.

During two weeks which we spent in the Bayumkol valley, we were busy with the investigation of the glaciers and their surrounding hills, Herr Pfann in addition taking measurements and making a survey, while Herr Keidel prepared a geological section of the valley and collected the material necessary for its corroboration. These labours were, however, often interrupted and sometimes hindered by two causes—inclement weather, and the refusal of the porters to work on difficult ground. The summer of 1902 was on the whole distinguished by unsettled weather. Moreover, in the high valleys of the Central Tian-Shan this variability was affected in a conspicuous manner by local conditions. As was often proved in the course of the journey, and as could be established from the meteorological observations, which were recorded regularly twice a day, each separate valley has its own meteorological character, which depends on the direction of the axis of the valley. For the Bayumkol valley the determining factor is that, being wide open to the north, it debouches immediately into the wide Tekes plain. The layers of air stagnating there and rapidly cooled during the night are, towards midday, set in violent commotion, owing to the uncommonly effective insolation of the floor of the steppe; they rush in storm towards the mountain range and penetrate the wide chasm

Digitized by Google

of the Bayumkol valley to its upper stretches, where, rapidly decreasing in temperature on the comparatively cold slopes, which extend to the north and north-east, they condense their vapour. The weather in the upper valley was, as a rule, good in the forenoon, but the force of the current of air, which regularly ascends from the plain in the middle of the day, is so great that it displaces that which, earlier in the day, prevails in the upper valley, and the latter does not regain its ascendency and restore calm till evening. With great regularity towards noon the air became dull; about two or three o'clock torrents of rain or snowstorms began, and afterwards, during the evening and night, fine clear weather prevailed. These winds, however, condense their moisture on the middle heights, and the highest ridges receive but little of it. At our headquarters, about 10,500 ft. (3,200 m.) high, the weather was always worse than at our camps, 3,300—6,600 ft. (1,000—2,000 m.) higher, where our work was mainly carried on. In the valley the precipitation was more continuous and more copious. The dry, loose condition of the snow on the extreme heights of the Tian-Shan (of which more hereafter) receives from these facts at least a partial explanation, though doubtless other circumstances are also partly accountable for it.

As for the porters, one-half of the Kirghiz deserted in the night, and the other half refused to serve, if they should have to climb on foot over

Digitized by Google

glacier ice at the higher elevations and carry on their back loads of quite moderate weight. Our discharged Kossacks were somewhat better, but they would not undertake what an Alpine porter of only average strength accomplishes with ease, to say nothing of the loads, carried by the natives in Sikkim and Kashmir. They usually showed the greatest aversion to snow at a great altitude, though I had equipped them all with Tyrolese shoes nailed for mountain wear, as well as crampons and ice-axes.

If to the unfavourable factors already mentioned there is added the bad condition of the high snow, which, especially on the northern and eastern slopes, lay dry and powdery on a surface of ice, one can easily imagine the wretched difficulties which opposed our investigations. I soon perceived that the extreme heights of the Tian-Shan are no proper field for the gratification of the Alpine craze. Our incipient purpose of climbing the "Marble Wall" had to be given up, since the porters could not be induced to carry the baggage, indispensable for a prolonged sojourn over heights of 16,000 ft. (5,000 m.), to a saddle at the foot of the north-western *arête* of the mountain. We had pitched our little mummery-tent at a spot free from ice, about 12,500 ft. (3,800 m.) high, on a depression in the north-eastern rampart of the eastern glacier. Thence we made excursions to the lofty granite peaks in the north-west, from 14,000 to 14,800 ft. (4,300—4,500 m.) high, wreathed with small glaciers. The granite is there altered in an

Digitized by Google

unusual and multifarious manner in consequence of mountain pressure. Next we went to the completely snow-clad schist summits, 16,500 to 18,000 ft. (5,000—5,500 m.) high, to the south-east of the high camp, to get from these heights an insight into the formation of the surrounding chains, and into the course of the valleys, which separate them, as well as to take photographic (especially telephotographic) panoramic views. These would be of great value for the completion of the topographic surveys, in which, moreover, the detail was obtained by photography.

Of these excursions the following was of special interest: On July 28th, soon after midnight, we left a bivouac at 14,000 ft. (4,300 m.) on the north-eastern rampart of the eastern glacier, and outflanked that obstacle by traversing in the dark, over dangerous ground, the south-west flank of a lofty snow-clad summit. We then climbed the next peak, about 16,500 ft. (5,000 m.), and descended several hundred metres to a snow-saddle, and again worked our way up to a similar dome-shaped ridge about 15,800 ft. (4,800 m.) high. Thence we descended towards the east, and thus reached the head of a hitherto unknown valley, quite filled with glacier ice. The course of this valley was first north-east, then east, and finally south-east, debouching in the neighbourhood of the Musart pass, and having thus a length of about twenty-six miles (forty versts). From the quite level ice-floor of the valley-head we turned towards the south-west, ascended about 1,800 ft. (400 m.)

Digitized by Google

over nevé-covered slopes and, passing over a wide snow-clad ridge, reached the foot of the north-west *arête* of the "Marble Wall." There a magnificent view opened out, towards the west over the wild glacier region of the Bayumkol, and towards the east over the far-stretching ice-field of the newly discovered valley. This is bounded on its south side by a commanding ice-clad range of splendid peaks, stretching away towards the Musart pass. In the deep bays between these peaks lie exceedingly rugged and picturesque many-terraced glaciers, which descend steeply to the main glacier. This range, branching off from the "Marble Wall," without doubt forms the main watershed between the northern and southern slopes of the Central Tian-Shan, as was proved to a certainty by subsequent observations from various points of view. I estimate the average height of the ridge of this chain at about 16,400 ft. (5,000 m.), and that of the peaks at more than 19,500 ft. (6,000 m.). There is only one deep depression in this mountain rampart. My expectation of seeing Khan-Tengri, towering up in it, was disappointed, and the question as to its position became ever more mysterious. It could not be far off, but in which of the valleys, lying behind this range, could it rise? Once more the inaccuracy of all the maps of this region was proved. There, where, according to the maps, Khan-Tengri should be, rises the "Marble Wall." The northern rampart of the ice-valley, though not so lofty as the southern,

Digitized by Google

is imposing enough; through the indentations of its crest we could see an ocean of peaks, many of which had never before been looked on by human eye. They belong, in part, to the mountain range, bounding the unexplored valleys to the north-east and east of our position, some of which, at least, I was able to traverse in the following year.

Owing to the nearly complete covering of snow and ice on these lofty ranges, one could see but little or nothing of their geological structure. That diabase must be represented in them was shown by blocks among the meagre débris at the head of the valley. In the following year I was able to determine their composition, which is identical with that of the range at the head of the Bayumkol valley. In viewing these mighty protuberances of the ground, rising round us, one could not but perceive that the broad masses of the mountain ranges east and west of my position are cleft only by the courses of a few deep valleys, evidently of very old formation, and are thus divided into single groups (*massifs*), whose roofs are in most instances furrowed only by elevated troughs or not very deep channels, separating narrow crests and numerous peaks which rise out of the plateaux. The mouths of these smaller elevated valleys, retaining snow and tiny glaciers, almost always lie very high above the level of the main valley. Without discussing this interesting subject, I shall only mention that at the time when the channels of the main valleys were still

Digitized by Google

filled high with ice, the small contributory glaciers in the upper valleys disembogued at the level of the surface of the glaciers in the main valleys. As the glaciers, both below and above, retreated (the tributaries far faster than the main glaciers), erosion by the action of flowing water was, in consequence of the rapidly increasing dryness of the climate, insufficient to contribute materially to the development of these newer valleys, while, on the other hand, in consequence of the enhanced destruction of the mountain crests, the filling up of the hollows with débris began and continued till these were again partially filled with snow and ice, owing to a renewed but less copious glacial period. In the configuration of the roof of these ranges, accordingly, we see the result of erosion and excavation no longer in vigorous action, while, in all the deep channels, especially during the interglacial periods, both continued and still continue to act very powerfully.

The continuously unfavourable condition of the weather in the Bayumkol valley caused me, though my labours were not yet ended, to leave it for the time and not return till autumn, when, with less conflict between the thermal conditions of plain and mountain, more settled weather might be expected. I wished to try whether better weather would not favour exploration in one of the larger valleys, the Sary-jass valley.

Digitized by Google

CHAPTER III

THE SARY-JASS VALLEY AND THE SEMENOFF GLACIER

We withdrew about sixteen miles (twenty-five versts) from the head of the (Bayumkol) valley, and then turned southwards into the Ashu-tyr side valley, already mentioned, which possesses great wealth of water, alpine meadow, and pine forests. The valley has an approximate length of sixteen miles (twenty-five versts), and, ascending steeply in three stages, stretches with many turnings, but on the whole in a south-south-westerly direction, following the strike of the gneiss; this often passing into granite, and alternating with limestones, phyllites, metamorphosed schists and especially marble schists forms the boundaries of the valley which especially in its lower course, are ruggedly peaked. Marbles and marble schists show, particularly at the head of the valley, great disturbance and extraordinary cleavage, due to fractures. The valley everywhere displays traces of its former ice-covering, not only in the deposits of drift, but also in the grinding and rounding of the lateral cliffs, noticeable in a high degree in the upper portion of the valley. Its supply of glacier-ice is no longer great, yet some of the many side-valleys, which open into it,

Digitized by Google

contain small glaciers, while two of them have glaciers of more considerable size, which, however, are also in a period of rapid retreat. Everywhere snow and ice (to be seen especially on the slopes of some rugged, massive peaks) are limited to northern and eastern exposure. At the head of the valley we made a very steep ascent over marshy meadow-land (water being everywhere in the valley surprisingly abundant), an old ground moraine, covering the mountain slope and reached a glacier, the crossing of which was very difficult for the horses on account of its covering of soft snow, and owing to crevasses, which the snow concealed. Crossing the snowy ridge about 12,800 ft. (3,900 m.) high, we reached the Karakol valley, which opens into that of Sary-jass.

I must here remark that the Kirghiz know no other name for this side-valley than "Karakol." This, after many inquiries, I was able to establish just as surely as that nowhere in the Tekes valley do the Kirghiz population or the Kossacks of Narynkol or the constituted authorities for the Bayumkol valley, apply to it the name "Karakol." Hence Herr Ignatieff is wrong, I think, in re-naming the real Karakol valley after his Kirghiz guide Bektur-bulak. Geographical names cannot be dealt with too carefully if one would avoid confusion. Dr. Friedrichsen, who, with the Saposhnikoff expedition, crossed by the same route as we did, but two weeks earlier and in the opposite direction, in his "Reisebriefen" calls the valley Ashu-tyr, a name which belongs

Digitized by Google

only to the valley, running from the pass northwards to the Bayumkol valley. Dr. Friedrichsen took this tributary for the main valley, though the far greater volume of the main river is alone sufficient proof that the main valley must lead at its southern end to extensive glaciers. The pass itself he calls Narynkol pass, evidently on the probably erroneous assumption that it is the identical pass, crossed by Ignatieff and by him called Narynkol. If the pass must bear a name, Ashu-tyr would be a more suitable one.

We made a steep descent from the pass in a south-westerly direction following the course of the Karakol glacier, which comes from dome-shaped, snow-clad summits, and is very little laden with drift. Our path lay in a hollow between the margin of the glacier-tongue, a wall of ice 100 ft. (30 m.) high, and the mountain side. The range here consists of phyllitic schists, stratified porphyry, granite, limestones, and extraordinarily riven marbles, as well as conglomerates and breccias, which are connected with the outcropping of the porphyry. In the limestones Herr Keidel found badly preserved fossils. The rock walls on both sides of the valley are polished to a great height by ice, and the lower part of the valley may be regarded as a type of a valley to a considerable extent shaped by, if not entirely due to, the action of ice. Besides the main glacier, which, after a course of about three miles (four to five versts), ends abruptly in its own débris about 3,700 m., there are two other considerable glaciers, which come in from the left, but their

Digitized by Google

tongues cling to the black slate walls, no longer reaching the main glacier; in a similar condition are a number of smaller ones, which lie in holes and corners of the rock sides of the valley. The lower course of the valley, much widened in consequence of faults (one is especially finely exposed), has been eroded into the form of a kettle, owing not only to the action of the main glacier, but also to the convergent action of the numerous secondary glaciers, which formerly forced their way beyond their actual boundaries concentrically into this valley, thus presenting a true object-lesson on the corrosive action of ice. Here also, in consequence of ruptures as well as of the grinding force of the ice and the weathering, which is peculiarly active, owing to the valley's being open to the south and west, an illustration of advanced destruction of the mountain range is presented, such as I had seldom seen in the Tian-Shan, rich as it is in phenomena of this sort. The southern and western exposure, favourable to an extraordinary insolation of the dark slate cliffs, and the consequent intensity of reflected heat, are the cause of a more conspicuous retreat of the main and the secondary glaciers than I observed in any other valley of similar altitude in the northern Tian-Shan. The main glacier at one time debouched seven miles (ten versts) below its present termination to join the giant glacier which formerly filled the Sary-jass valley. On a green terrace of old morainic drift, near the spot where the Karakol stream now flows into the Sary-jass river, I had

Digitized by Google

my headquarters at about 11,500 ft. (3,500 m.), whence excursions were made for the exploration of the Semenoff glacier and the ranges, surrounding it.

According to the publications of certain travellers, who visited the Sary-jass valley and penetrated some versts upwards on the ice of the Semenoff glacier, this ice-stream would appear to be fed from the snow-fields of Khan-Tengri. If this were the case, the mountain would be situated in the background of the ice-valley; but the course of the valley winds about, and even from elevated positions its background cannot be recognised with sufficient certainty, and the less so that broad side-valleys, which themselves have branches, debouch near the valley-head. From many points on the margin of the Sary-jass valley Khan-Tengri is seen, however, always in such position, that one is constrained to believe it can only rise at the head of the Semenoff glacier. Yet, since in the Bayumkol valley I had settled how far the Semenoff glacier stretches northwards; I was doubtful of this assumption. Taking advantage of favourable weather we forthwith ascended a mountain, towering immediately behind our camping-ground, on the north side of the valley. From this snow-crowned level, about 13,800 ft. (4,200 m.), there is an excellent view over the glacier ranges of the Central Tian-Shan. The favourable position of the point reached, the pellucid air, and the extraordinarily clear light made it possible to take a telephotographic panorama in twelve sheets of 8 by 10 in. which

Digitized by Google

will be of great value for the determination of positions as well as of the form and course of the mountain chains, which constitute the loftiest portion of the Tian-Shan. The view over these commanding ranges showed that Khan-Tengri has no rivals of even approximately equal nobility. Though many summits may reach a height of over 20,000 ft. (6,000 m.), and a few even 1,500 ft. (400 m.) higher, the slender pyramid of Khan-Tengri still overtops and dominates them all. In these hurried notes all I can say concerning the relative elevation of the Central Tian-Shan is, that the greatest altitudes are in the mountains surrounding the Bayumkol valley, especially those between it and the Semenoff glacier, though these may be surpassed by a few of the noble peaks to the south of the Adyr-tyr or Mushketoff glacier, but that these are all excelled by the mountains on the southern boundary of the Inylchek glacier, and that at all events the average crest and peak altitude of this range must be regarded as the highest in the Tian-Shan, a gradual slope towards the south beginning here. From our standpoint we could establish with certainty that the "Marble Wall" is identical with the summit which on all the maps is marked as Khan-Tengri (*vide* p. 88,) and, though its whole importance as a centre of ramification was not completely proved till later, one could even now see that in its neighbourhood a parting of divergent ranges takes place. The grouping of the crests round the topmost pyramid of Khan-Tengri, however, as seen from this point, was such

Digitized by Google

that one could not say, even with remote confidence, from which of the valleys it rises, especially as in its neighbourhood, about north-east from it, there is a seemingly confused crowding together of mountain ranges, approaching from different directions. It could be conjectured, but not settled, that the base of Khan-Tengri, the lord of the Tian-Shan, lay in the Inylchek valley.

Some hundred metres below the top of our plateau there extends, like a shoulder of the mountain, a terrace on which Herr Pfann marked out a base line and fixed its position by astronomical observations. From this he determined the position and height of Khan-Tengri and others of the most prominent points of the Central Tian-Shan, while I set about the exploration of the Semenoff glacier and its boundary ranges, and Herr Keidel busied himself with the investigation of the geological structure of the range, surrounding the Sary-jass valley below the camp, for which purpose he made excursions into the side-valleys on the right bank. Where extensive faults occur he found schists, phyllites, limestones, granites and diabases, which had fallen in small flakes to various levels. In the Kashka-su valley he was fortunate in finding Devonian limestone. The geological stratification and composition of the valley ranges shows similarity to those of the Bayumkol valley, but in the Sary-jass valley diabases are more widely diffused than in the Bayumkol. More detailed notes are reserved for the special geological report. The Sary-jass valley is the most extensive and

Digitized by Google

the most important of all the valleys of the Central Tian-Shan, since it forms the great channel for the waters, flowing south to the Tarim. Its present configuration without doubt has been affected by a glacial period.

The merit of having first pointed out the significance of the glacial deposits which are found in the valley, belongs to P. P. Semenoff; the wide diffusion of these deposits is, however, even more important, as this famous explorer has himself acknowledged. I could observe these and other signs of the action of ice in the main valley and its secondary valleys up to 1,650 ft. (500 m.) above the present level of the river, to such heights, that one might infer that formerly the valley was almost completely filled with glacier ice. In comparison with the thickness of former glaciers, that of the beds of nevé and ice, still found in the main valley and its tributaries, is insignificant; nevertheless, these form one of the largest glacier regions in the whole of the Tian-Shan, and are, as will be proved by the results of my exploration, in any case much more important than has hitherto been believed. The largest glacier of the region is the Semenoff glacier, which hitherto was supposed to be the largest of the Tian-Shan. I had the good fortune in the course of the expedition to obtain proof that it is exceeded in length by other ice-streams, one being more than double its length. But also, the extent of the Semenoff glacier has been hitherto under-estimated. According to Ignatieff, who visited it in 1886, its

Digitized by Google

length is about seven miles (ten versts) whereas it is actually about three times that length. Of its breadth and the breadth of its tributary glaciers there was on the whole up till now no proper idea.

From various causes, partly also as a result of the westerly direction of the axis of the upper course of the Sary-jass, we observe the rare phenomenon that the main glacier has retreated to a greater extent than the still existing side glaciers, which—at least, those debouching into the upper course of the valley—have almost kept their early horizontal length, if not their former thickness. This, however, is true only of those which debouch on the (orographic) left bank, since their axis is directed towards the north. Their tongues at the debouchement hang like patches of ice over ground-moraine débris 600—900 ft. (200—300 m.) above the present floor of the main valley, where this is free from ice. Of those which now terminate in the region of the main glacier as it at present exists, the tongues of the first three no longer reach it, but hang 300—500 ft. (100—150 m.) above the level of its surface. All the secondary glaciers farther east debouching on the main glacier, some of them of great extent, unite with the main stream, and the level of their floor as a whole lies in one plain with that of the latter. The unusually gentle slope of all these ice-streams (it is only 25 m. per verst or 126 ft. per mile in the middle and upper course of the main glacier) might, in my opinion, point to a considerable

Digitized by Google

filling-up of the channels of the valley with mountain débris at some time when they were not yet covered with ice.

The side-valleys, debouching on the right bank —at least, those debouching into the portion of the main valley, now free from ice—have, where their axis is directed towards the south, no longer any glacier; only at the head of some of them small fields of nevé lie in recesses (Kare). The mouths of these side-valleys lie from 650 ft. to 1,000 ft. (200—300 m.) above the bottom of the main valley; to reach them one has to climb up steep, green, marshy ground-moraines. While the chain on the left bank is cut into by numerous side-valleys, whose own boundary walls, also deeply indented, seem broken up into many steep and variously shaped peaks, the chain on the right bank is divided by relatively few side-valleys, and the walls, bounding these show far fewer broken crest-lines and more plateau-like tops, shattered crests with superimposed tent-shaped peaks. The forces at present at work in the formation of mountains do not account for these facts, which rather point to the conclusion that, prior to the beginning of the actual ice-covering of the mountain range, erosion was more powerfully at work on the slope exposed to the north, and destruction (deflation) more on that exposed to the south, and consequently that the climatic conditions were then similar to those now prevailing, though they may have been less sharply accentuated. At the

Digitized by Google

same time, the high angle at which the strata composing these ranges are set must be taken into account.

Several miles below the tongue of the Semenoff glacier the bottom of the valley is hollowed out to a basin about a mile and a half (two versts) wide, its level floor covered with shingle. At some former time the water from the glacier had been dammed up here by terminal moraines, so as to form a lake; the basin still holds some small relics of lakes. The streams from the glacier are still busy, cutting up and carrying away the remains of the old moraine ice-drift, which still exists in considerable masses. To the climatic difference between the two banks is to be traced the fact that the tongue of the glacier runs along the south bank for more than a verst, where the north bank is free from ice. I subsequently observed like phenomena in other Tian-Shan glaciers with similar exposure. The tongue of the Semenoff glacier ends at about 12,000 ft. (3,600 m.) altitude, according to observations taken in two consecutive years. The climatic difference is shown also in another way, the mountain chain along the bank facing southwards having snow and ice only on its summits, which are but slightly divided, while its deep rocky precipices retain these only in ravines and channels; whereas the chain looking north is wrapped in a bright garment of snow and ice, which seldom shows a rent. This range, much divided, stretches eastwards as a row of mighty

Digitized by Google

snow-clad, round-headed mountains, horn-shaped peaks, and steep ice-ramparts, presenting a magnificent spectacle. In the middle and upper course of the glacier, where its axis is directed more to the north-east, the bounding range on the right bank also appears to a large extent covered with ice, though neither in this respect nor in imposing mountain shapes does it equal the chain on the left bank, which, besides, is loftier. This, and also the circumstance that the glacier bottom slopes towards the north, are to be traced to the gradual rise of the collective mountain mass towards the south. In consequence of the slope of the ice-bed towards the north, the water from the ice tends to flow to the north bank, and the main stream therefore springs, not from the end of the ice-tongue, but some versts above, from a cavity in the precipitous right side of the tongue. I was able to observe similar phenomena, due to similar causes, in the other great glaciers successively towards the south.

The glacier has, near its tongue, a breadth of about 5,000 ft. (a verst and a half), but widens farther up and attains in its middle course a breadth of more than two miles (three versts). In its lower course its surface is free from snow, but is covered with some débris, though to a less extent than other great glaciers of the Tian-Shan; here it is only furrowed by some deep troughs, owing to peculiar conditions of insolation, dependent on the form and exposure of the mountain walls, and also due to erosion by melting water; elsewhere it is uneven,

Digitized by Google

in places wavy, but not penetrated by crevices to any great extent. Generally the cleavage of the surface is comparatively slight, partly in consequence of the gentle slope and the evenness of its base, which I have already mentioned; partly on account of the absence of lateral pressure, since, apart from the immense size of the basin, the ice on both sides is separated from the rocky banks by deep chasms; and lastly because, as already stated, most of the secondary glaciers join the main glacier without any descent. The principal regions of cleavage are at the arched edges, mostly on the right side. There are only a few places at which *seracs* have been formed.

In consequence of its great extent and its gentle slope the Semenoff glacier is fairly constant. I have visited it in two consecutive summers, have roamed over it in all directions, and altogether have spent more than two weeks on its surface, but neither at its terminal tongue nor at its edges could I find any indication of shrinkage in recent times. If a traveller, who paid a flying visit to the lowest part of the glacier some years ago, reported on its rapid and continual melting away, he was probably induced to take this view by the many rivulets, gushing over the ice, such as are formed in the case of every great glacier (even in the European Alps, though perhaps in less degree) in the midday hours of hot summer days. But for the melting away which takes place in the course of a brief Tian-Shan summer under the climatic conditions now prevalent, ample com-

Digitized by Google

pensation is made by the extraordinary amount of snow and ice which the Semenoff glacier receives, especially from the very large secondary valleys of its upper course. So long as there exist such immense stores of snow as I have seen in the vast, hitherto untrodden interior of the Central Tian-Shan and so long as their masses, impelled by their own weight to lower altitudes, continue to deliver abundant material for the formation of nevé and glaciers, there is, in my opinion, no danger of a complete drying up of the Tian-Shan, such as has been frequently mooted. These vast stores of snow, not only on account of the dry condition, peculiar to snow at great altitudes in the Tian-Shan (*vide* pp. 30, 31; more concerning this hereafter), but also on account of the low temperature of the air at these elevations, undergo very trifling diminution through melting or sublimation, but on the contrary are increased by new falls of snow. On this interesting subject and on the phenomena connected with it, I must not further enlarge within the limits of this report.

Of all the great glaciers of the Central Tian-Shan which I have visited, the Semenoff glacier, on the whole, shows in its general habit most resemblance to the great glaciers of the European Alps. Only in one point it is essentially different from them: With respect to its great wealth in ice-lakes, and with respect to their origin and disappearance, I shall state my opinion in a more detailed report. Most of them are funnel-shaped, and they are rather irregularly arranged on both

Digitized by Google

banks of the lower and middle course, but are more numerous on the right bank. Many of them have considerable length, 640—1,000 ft. (200—300 m.), and present a magnificent spectacle when the ice-capped giants surrounding the glacier valley are mirrored in their green or blue waters. The difference in their colour, some being green, some blue, is a highly peculiar phenomenon. In the upper course of the glacier there are no ice-lakes, but in the moraines on the right bank there are numerous moraine-lakes, not inconsiderable in size. The snow-covering begins in the middle course, and is very thick in the upper course. A nevé basin, resembling a lake, a mile broad, oval, trough-shaped, and rising in two stages, but elsewhere with only a very slight incline, forms the north-eastern and highest portion of the glacier, which is enclosed by the southern wall of the western Bayumkol glacier. In this range, in which some magnificent snow-peaks rise to a height of more than 20,000 ft. (6,000 m.) there is a deep depression, easily accessible from the uppermost snow trough, and to this, since it lies at the very head of the Semenoff glacier, I have given the name of the Semenoff pass. With a favourable condition of the snow-covering of the Bayumkol glacier, one would probably be able to descend through this opening into the last-named valley. The total length of the Semenoff glacier from its terminal tongue to this pass is about twenty miles (thirty versts).

The masses of mountain débris, transported by

Digitized by Google

the glacier are comparatively small; the lateral moraines have become bank moraines; the middle moraines (there are only two) receive but little material, since the great side-valleys, one of which, with an average breadth of 3,500 ft. (one verst), has an approximate length of seven miles (ten versts), are bounded by magnificent mountain chains, whose splendid snow and ice mantles show, however, but few rents. In the lower reaches of the lateral moraines, granites and limestones predominate and elsewhere chloritic schists and clay-slate, though limestone as a rule is found only in the left moraine, since the limestone crops out from a bed on the left bank, which runs north-east and does not again reach the right bank. The middle moraines consist almost entirely of granites of varied structure, and of granite porphyries, pegmatite, and syenite, with some clay-slate; but these rock fragments become scarcer the nearer one approaches to the upper course of the glacier. Here we meet with increasingly metamorphosed limestones, slates, and white marbles, and also fragments of diabase and diabasic slates. This leads to the conclusion that the innermost boundary range consists only of this rock series.

All accurate insight into stratigraphic relations is prevented by the thick snow mantle, covering the bordering ranges. On the right bank, where snow-free slopes occur here and there, the ground is covered with a chaos of blocks.

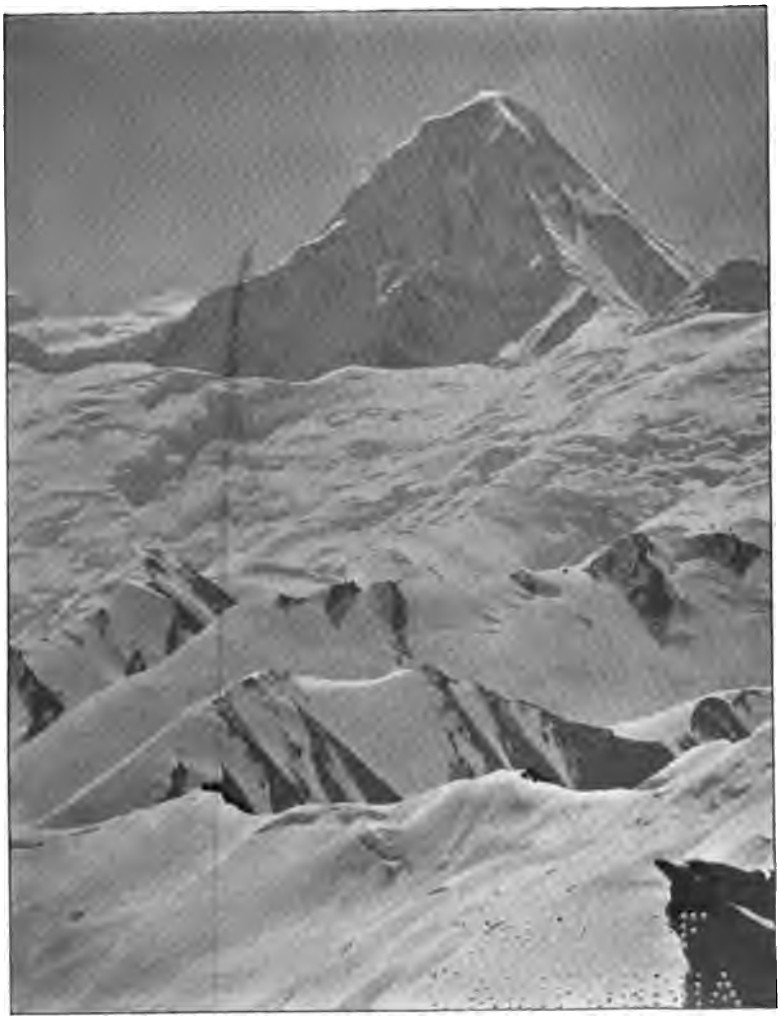
Unfortunately, in Sary-jass also our work was little favoured by the weather, although it was not quite so unsettled as in the Bayumkol

Digitized by Google

valley. From a bivouac on the right margin of the moraine, about 12,800 ft. (8,900 m.), some ten miles up the glacier, Herr Pfann and I with the Tyrolese Kostner ascended a snowy pyramidal peak, rising to about 15,750 ft. (4,800 m.). From its summit was unfolded to our view in all its imposing magnificence the vast icefield with its ranges of peaks completely snow- and ice-clad, beyond which were visible the still loftier wonderful mountains of the Mushketoff and of the Inylchek glaciers—altogether an Alpine prospect, such as is to be seen in few other parts of the globe. The pyramidal cone of Khan-Tengri was visible away to the south-south-east beyond a broad snowy summit, surrounded by several intercrossing ridges, so that it seemed already evident enough that Khan-Tengri has no connection with the Semenoff glacier, although in the absence of any trustworthy topographic information it was impossible to say from what valley it rises. The northward view from our summit was specially instructive as to the conformation of the complex mountain system, stretching between the Bayumkol, Karakol, and Kapkak valleys, as well as the trend of the upland valleys, ramifying through it. This was a welcome addition to the observations, which we had already made from the heights of the Bayumkol valley. There was just time to take a number of photographic pictures of the whole scene when a sudden snowstorm put an end to our observations.

Being determined to solve the riddle of the

Digitized by Google



TELEPHOTOGRAPHIC VIEW OF THE SUMMIT OF KHAN-TENGRI (ABOUT 23,610 FT.), TAKEN FROM NORTH-NORTH-WEST, FROM A PEAK (ABOUT 16,000 FT.) ON THE SOUTHERN MARGIN OF THE SEMENOFF GLACIER. DISTANCE ABOUT 5 MILES.

[*To face p.* 52.

Digitized by Google

UNIV. OF
CALIFORNIA

Digitized by Google

position of Khan-Tengri, we proposed the very next day to make the ascent of the highest point at the head of the Semenoff glacier. This is a superb, broad, snowy peak, which is encircled by a system of wild séracs and crevasses, and rises some seventeen miles above the tongue-end in the north-eastern extremity of the glacier, its highest point exceeding 19,685 ft. (6,000 m.) by a few hundred metres. This wonderful mountain, which dominates the whole basin of the Semenoff glacier, I have named the "Semenoff peak," in perpetual memory of the great services rendered by the energetic President of the Imperial Russian Geographical Society to our knowledge of the Tian-Shan.

We started from our elevated station soon after midnight. With some difficulty we approached the right margin, threading our way in the dark through the system of lateral crevasses which, owing to the sharp bend of the valley to the north-east, is here very intricate. Unluckily I stepped into a crevasse, thereby so severely spraining my left foot that, although still able to get on that day with some trouble, I was afterwards fain to reserve my strength and prevented for some time from taking part in trying excursions. After a rapid march of some eight miles over hard-frozen snow we reached the foot of the last stage of the glacier, from which access is gained to the highest nevéfield, which is still some three miles distant from the "Semenoff pass," the extreme point. From this stage of nevé we ascended across steep, much-fissured snowy slopes in an approximately easterly direction

Digitized by Google

and made good progress over the snow, which, thanks, to the early hour (5 a.m.), was in a favourable condition. We soon reached a considerable altitude, so that we felt a confident hope of scaling the top of the giant mountain, and from it at last acquiring some certainty, regarding the position of Khan-Tengri and the ramification of the loftiest crests.

This hope urged us rapidly forward; but as we mounted higher and higher, up to an elevation of some 16,400 ft. (5,000 m.), the hard-frozen surface gradually gave way under our feet and, henceforth, was formed of snow, which assumed more and more a powdery consistency. I have already indicated one of the causes of this phenomenon (*vide* pp. 30, 49). The moisture precipitated as snow on the extreme heights of the Tian-Shan possesses a peculiar crystalline form, and is dry as powder. The atmospheric strata of these altitudes are unusually dry, but on snow of this nature they cause no appreciable amount of evaporation. Moreover, even under the influence of insolation the surface layers cannot, owing to the constant circulation of the upper atmospheric strata and their low temperature, thaw during the day, and consequently cannot form a frozen crust at night. If anywhere, such processes take place on the slopes, facing south and west, though even there only to a small extent, but as a rule hardly at all on those with a northerly or easterly exposure. There, on the contrary, the severe night frosts only make the snow all the drier. This prevents any congelation, and one sinks a yard deep in the powdery snow. But when this powdery

Digitized by Google

snow lies on a layer of old snow, which by the above-mentioned processes has acquired a glacial surface in any places, favourable for such a formation, or else has been gradually hardened by the pressure of the overlying layers, then there is great danger of the loose surface layer, when trodden upon, breaking away from the steep slope and gliding with the persons trespassing on it down to the bottom. In a few days this was, in fact, verified. For us, however, there was no imminent analogous danger during the ascent; but we sank at every step to the middle, and could no longer find any firm footing. All our efforts failed to discover a zone of snow in better condition by changing the direction of our ascent.

In order to divide fairly the toilsome labour of treading down the snow, we changed the leader every ten minutes. Still the strength of the three Alpine climbers gradually flagged, and despite the most heroic efforts, we no longer made any appreciable progress. There were still to be surmounted over 3,300 ft. (1,000 m.) of absolute elevation, which, taking into account the angle of the slope and the winding of the way, was equivalent to a distance of over 5,000 ft. (1,500 m.). Even if our strength was equal to the task, which was not to be thought of in such snow and in such extremely rarefied atmosphere higher up, night would have overtaken us on the summit. And how easily might the weather have changed, so that even then we should have no longer been able to make observations.

Digitized by Google

The undertaking had to be given up as hopeless. Still, it was not quite useless, since the prospect from the elevation attained gave us much supplementary information.

The state of my foot obliging me to return to headquarters, my place was taken by Herr Keidel, and one of the Narynkol Kossacks was summoned to carry the large photographic apparatus. The party now ascended a summit 15,100 ft. (4,600 m.) high on the southern margin of the Semenoff glacier, the primary object being to take photographs and to obtain bearings for our further investigations. From this point Herr Pfann's next goal was a mountain, rising on the southern margin of the neighbouring Mushketoff glacier, which runs parallel with the Semenoff. The assumption—verified a year later—was that from the top a decisive view must be had of the valley, towering above which, the pyramidal crest of Khan-Tengri is always seen.

As the mountain at least its flank up which the ascent was to be made, is not very steep, and moreover faces west, all the conditions were present for a successful issue.

At midnight the party of four started from a camp 18,450 ft. (4,100 m.) high, situated on the left margin of the Semenoff glacier at the junction of a broad level secondary glacier valley. They traversed its course of about five miles, and thus before daybreak reached the foot of a broad low ridge, which is crowned with stunted snowy domes and separates the Semenoff basin from the upper

Digitized by Google

part of the Mushketoff glacier, of which more anon. A deep depression about 14,450 ft. (4,400 m.) in this valley—which I name the "Mushketoff pass" in honour of the never-to-be-forgotten naturalist, Mushketoff—was now surmounted. As the surface of the Mushketoff glacier is here about 500 ft. (150 m.) higher than that of the Semenoff glacier, but little height was sacrificed in descending to reach it. It was crossed from side to side at a point, where it is about two miles wide, so that by day-break the party reached the foot of the completely snow-clad mountain on the opposite margin, which was to be ascended, and had an altitude roughly estimated at 17,700 ft. (5,300 m.). Scaling over a snowy ridge, trending away to the west, they reached the shoulder of the mountain and began the ascent on the west flank of the actual summit itself. All went well, and the snow remained firm under the feet of the climbers, who were connected together by a stout Alpine rope. Towards 11 o'clock in the forenoon they found themselves within 300—600 ft. (100—200 m.) of the very top of the mountain. Then was heard a sudden crash: a surface layer of snow, loosely overlying a substratum of hard snow had cracked; it gave way and slid towards the bottom with all four climbers. They all seemed lost, when their downward course was fortunately arrested by a small snowy ledge projecting some 650 ft. (200 m.) deeper out of the slope. All four were able to work their way uninjured out of the snowy masses, and nothing had to be regretted, save the loss of some hats and ice-axes, which could not

Digitized by Google

be recovered. The Kossack, paralysed by fright, completely lost his senses. The three others were inconsolable at the failure of the attempt, which in Herr Pfann's opinion must have led to the discovery of the position of Khan-Tengri; yet another year elapsed, before he was found to be right. So near to the wished-for goal had their hopes been wrecked.

And now for me the outcome of all past experiences was that in the highest regions of the Tian-Shan it was perhaps only under quite exceptionally favourable conditions that the snow can acquire that consistency which permits the ascent of peaks, rising above 16,404 ft. (5,000 m.), unless indeed it can be made on rocky ground. Only the lofty rocky crests are for the most part extremely precipitous, and, as appeared from further experiences, owing to the influence of excessive thermal contrasts, so profoundly shattered that the attempt to scale them often encounters unsurmountable obstacles. Ascents through rocky gorges and couloirs have to be avoided on account of the great risks, incurred from falling stones. Hence only a very few of the loftiest Tian-Shan summits hold out favourable prospects to the Alpine climber.

Bearing this in mind during the subsequent course of the expedition, I avoided difficult Alpine undertakings, and henceforth ascended only such mountains as might from their position offer the promise of commanding prospects, affording an insight into the structure of the mountain range,

Digitized by Google

and at the same time seemed accessible to experienced Alpinists without exposure to great danger.

Meanwhile a period of unfavourable weather had set in, and all operations were prevented by daily snow-storms. This obliged me to leave the Semenoff glacier, the accurate measurement of which by triangulation was not carried out till the following year. As we had made sure that Khan-Tengri does not lie too within the basin of the Mushketoff glacier, I decided at once to penetrate into the next great parallel valley, that of the Inylchek, and there look for it.

Digitized by Google

CHAPTER IV

TO THE INYLCHEK GLACIER AND FARTHER SOUTH

We moved some twenty-three miles down the Saryjass valley, which soon loses its picturesque aspect. Owing to the already mentioned causes, the chain, skirting the right bank, shows rounded crests, pierced only by a few upland gorges, but no glaciers. The left bank still maintains for a short distance its high Alpine character. It is disposed in separate sections by deep transverse valleys, harbouring glaciers. These glaciers breaking out from the ravines, combined with the glittering snows of the peaks enclosing them, form a lovely contrast to the deep green of the main valley and its slopes, carpeted with Alpine meadows.

The most important of these tributaries is the Adyr-tyr valley, which above its mouth, turning in a swift course to the east, flows approximately parallel to the Semenoff valley, which it nearly rivals in length, breadth, and wealth of glaciers, and even surpasses in the height and grandeur of its mountains. Its upper course is filled by a glacier, which Ignatieff has named the Mushketoff glacier, of which more farther on.

Digitized by Google

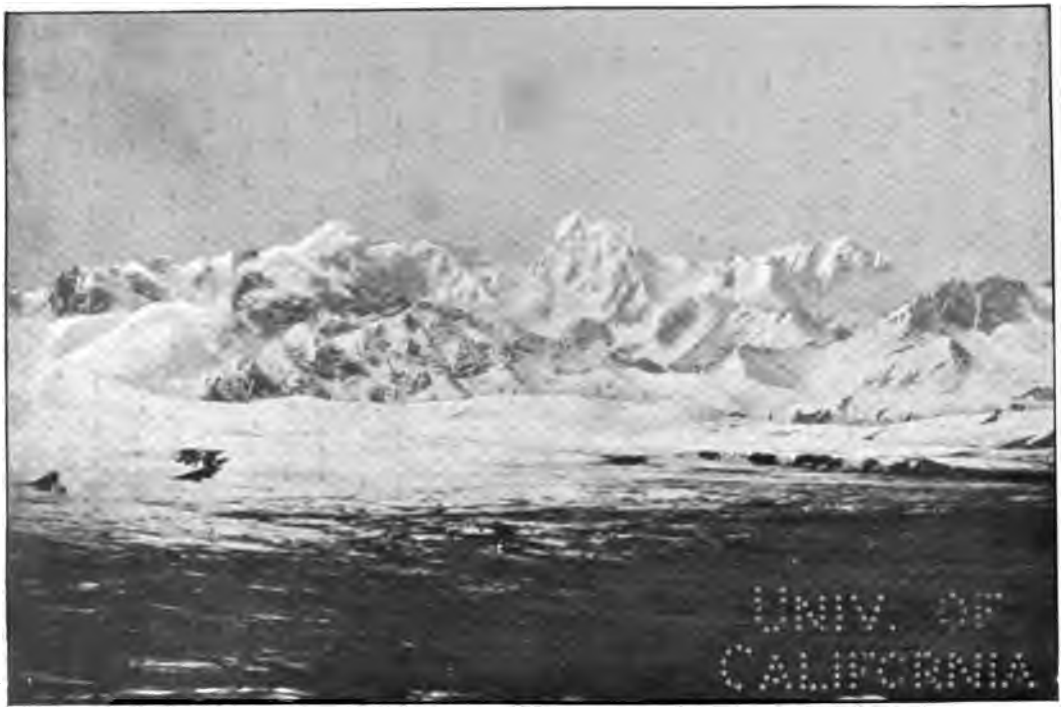
The wide green prairies of the Sary-jass, averaging one mile, but in places broadening out to two miles, showing the character of the treeless and scrubless upland steppe, display soft rounded forms, which are due to the old morainic deposits, fringing the scarps of the valley. Such lateral moraines on the left side, well preserved in two stages, accompany at intervals the upper course of the valley. On the right side, even on the plateau-like ridges are morainic deposits and débris now to be seen, frequently also glacier scorings high up on the rocky walls. The valley-bed is filled with old ground-moraines, covered by marshy meadows with small tarns, relics of the large lakes, which, being dammed up by terminal moraines, formerly filled the basin-shaped expanses. The origin of some of these expanses is obviously due to the lateral erosion of the river. Another, above the Adyr-tyr valley, has been caused by a kind of cleavage (*Scharung*), the ridges receding from each other in consequence of some sudden change in the strike of the strata. The phenomenon must in some way be connected with the already-mentioned (*vide* p. 42) faults and fractures in the lateral valleys. At the mouth of the Adyr-tyr valley, over one verst broad, the granite and the phyllitic rocks associated with it, disappear below the surface; the limestones of the chain on the left bank of the Adyr-tyr valley strike outwards, and form farther on in the Sary-jass the southern ramparts, whose ridges hence rapidly diminish in height. Beyond them the superb glaciated highlands of

Digitized by Google

the Kulu-Tau come into view, with an extremely bold eminence, towering up as a solitary peak. The slates and marbles, present on the right bank in flakes are absent on the left bank.

From a broad gap in the limestone range on the left bank some seven miles below the mouth of the Adyr-tyr, the copious Tys-ashu river flows to the Sary-jass, and drains a much-ramified valley region, not shown on the maps. This group of valleys lies in a tangle of mountains with a north-westerly slope, and is enclosed between the high range, forming the left bank of the Adyr-tyr valley, trending north-westwards, and the chain, stretching south-westwards along the right bank of the Inylchek valley. In the obtuse angle, formed by the two widely diverging chains, lies an extensive plateau-like nevé, which is gently inclined, and in both chains develops blunt, tent-shaped, snowy summits. From the breaks between these eminences, sweeping round in a wide curve descend flat, trough-shaped ravines, filled with nevé, and disposing in radiating sections the broad stretches of land, which slope quite gently down to the Sary-jass valley. By a lofty plateau ridge, "Tur," which has escaped all erosive action, the whole system of valleys is disposed in two groups —that of the Kusgun-ya valleys, which will be discussed farther on, and that of the Tys-ashu valleys. Kongul-jol, Achik-tash, Mai-bulak, Tys-ashu I. and II. are the names of the more important radiating head-channels, which unite in a main stream also called Tys-ashu (Tys-ashu means the

Digitized by Google


UNIV. OF
CALIFORNIA

TELEPHOTOGRAPHIC VIEW OF KULU-TAU, TAKEN FROM A POINT (ABOUT 11,000 FT.) IN THE MIDDLE COURSE OF THE SARY-JASS VALLEY. DISTANCE ABOUT 40 MILES.

[*To face p.* 62.

Digitized by Google

Digitized by Google

ramifying of a level tract). The tracts of nevé which lie in the broad, shallow upland troughs of these valleys are at present separated one from the other by considerable masses of morainic refuse, disposed in ridges. Two only still show conspicuous stretches of glaciers, which, however, soon come to an end amongst the débris of their ground-moraines.

From the whole aspect of the land it is seen at once that all that now remains of isolated nevé is but the remnant of a once continuous and very extensive ice-cap. From these glacial masses was developed a huge glacier, which formerly spread over the lower parts of the district, and joined the at-one-time-mighty Sary-jass glacier. The whole of the wide Tys-ashu domain, which is amongst the favourite grazing-grounds of the Kirghiz, presents a superb morainic landscape of a typical character, such as is elsewhere rarely to be seen. The rocky walls, too, are polished to a great height by glacial action. Standing later on an elevated position, I was able to ascertain that the great glacier, to which it owed its existence, was formed by the combined glacial masses of the southern border-range of the Mushketoff glacier and the chain, skirting the north side of the Inylchek glacier. In the trough-shaped depression of the Tys-ashu district the hills are literally buried beneath morainic drift, now covered with swampy Alpine meadows, so that only in a few places the rocks are seen cropping out—limestone disposed in narrow folds, stretching northwards, granite, and phyllitic schists.

Digitized by Google

Just here the chain on the north side of the Inylchek valley is greatly depressed, while the southern range under the same meridian is upheaved to one of its highest elevations, one of the most imposing mountains in the whole Tian-Shan system. Hence to a person, standing in the lower part of the Tys-ashu valley, and looking upwards along the broad, gently rising, trough-like valley, the deceptive impression is conveyed that the extensive nevé at the head of the valley runs straight up to the wild and precipitous glacial walls of the huge Inylchek peak, which seems to close the Tys-ashu valley. What lies between remains hidden from the eye of the observer. Evidently this impression misled Professor Krassnoff himself when, in bad weather too, he penetrated a little way into the Tys-ashu valley, named by him the Tesnyk-basy.

He writes (*Sapiski, Imp. Russ. G. G.* vol. xix. 1888, p. 89): "The third glacier, which is not even mentioned by Ignatieff, and is omitted even on his map, is the glacier which lies at the foot of Tesnyk-basy, perhaps one of the highest peaks after Khan-Tengri, and bears, like the peak, the name Tesnyk-basy. This glacier with its snow-fields is obviously connected with those of the Inylchek glacier region. The valley of the Tesnyk-basy, the second affluent of the Sary-jass on the left, I followed as far as the frontal moraines of this glacier, which was evidently but little inferior to the Mushketoff glacier. To my regret I was prevented by the bad weather," etc.

Digitized by Google

VIEW FROM A PLATEAU BETWEEN THE SARY-JASS AND TYS-ASHU VALLEYS (ABOUT 10,500 FT.), UP THE TYS-ASHU VALLEY TO A HUGE PEAK, STANDING IN THE SOUTHERN BORDER-RANGE OF THE INLYCHEK VALLEY.

[*To face p.* 64.

Digitized by Google

Digitized by Google

In the dividing wall between Tys-ashu and Inylchek there occurs an ice-clad pass about 13,300 ft. (4,050 m.), which, as affording the nearest access to the Inylchek valley, I crossed with the caravan, though not without some difficulty. This I call the Tys-ashu pass. During the ascent of the pass the track lies between limestones and limestone schists, which have an east-north-east trend, but in the vicinity of the pass, develop folds dipping north and with granite cropping out along their edge. Owing to its close contact with the granite, very little of its great wealth of fossils has been preserved by this carboniferous limestone formation. Nevertheless, by repeatedly crossing the pass we managed later, to collect some that could be identified. On the south side of the pass the limestones are tinged red, calcined, and greatly disintegrated. There also occur conglomerates and friction-breccias, indicating the discharge of eruptive matter from a spot, which I was later able to locate on the north-east side of the pass in the neighbouring Kusgun-ya valley.

Flanking the gate-like entrance of the pass there shoot up hundreds of obelisk-like limestone crags, into which the masses have been decomposed by the marvellous action of erosion. If from these strange surroundings we turn to the south and east, we see, some 3,300 ft. (1,000 m.) lower down, the boulder-strewn floor of the broad trough of the Inylchek valley, walled round by many-crested snowy ranges, whose crest-line rises with an average elevation of over 8,000 ft. (2,500 m.)

Digitized by Google

above the valley bottom. The eye also lights a little higher up on an ice-field of extraordinary extent, similarly bordered and stretching away to the east.

Even though the observer be accustomed to the sight of the loftiest eminences on the globe, the Himalayas, Karakorum, etc., a feeling of wonder and amazement will still be produced by the first view of the extraordinarily abrupt southern border-range of the Inylchek valley. Here are unfolded the mightiest elevations of the Tian-Shan. A gigantic range, surmounted by the wildest and most rugged snowy peaks of the most diverse forms ever sculptured by the creative forces of nature, is seen stretching away to the east for a distance of some fifty miles, altogether one of the grandest Alpine pictures on the globe. Amid this proud phalanx the most magnificent is one mountain which rises opposite the pass, the same that, as already stated, is partly visible from the Tys-ashu valley. It is difficult to conjure up an adequate picture of the mighty, far-reaching spurs of this giant, of the wildness of its many fractured crests, the splendour of its precipitous glaciers, carved in a thousand varied forms and broken into endless fragments. I do not hesitate to pronounce this marvellous mountain mass, some 21,300 ft. (6,500 m.) high, to be the grandest in the Tian-Shan. For it an appropriate name should certainly be found. The Central Tian-Shan attains its highest mean altitude not, as hitherto supposed, in the southern chain

Digitized by Google

PEAK (ABOUT 21,300 FT.) IN THE SOUTHERN BORDER-RANGE OF THE INYLCHEK VALLEY, TAKEN FROM OPPOSITE, FROM BELOW THE TYS-ASHU PASS.

[*To face p.* 66.

Digitized by Google

Digitized by Google

of the Semenoff glacier, but in this range, whose crest trends away to the east-north-east at an average elevation of 18,000 ft. (5,500 m.). From this point there is a gradual fall of the mountain mass towards the south. To our surprise, however, Khan-Tengri, the absolutely highest eminence of the Tian-Shan, did not appear in this range, and the question of the position of its actual basis still remained unsolved.

Seen from the pass the Inylchek glacier already produces a profound impression, although its lower section, being for many miles completely covered with débris, has not at all the air of an ice-stream, and, owing to the windings of its bed, its whole course cannot be taken in at a glance. Nevertheless, it struck us all at once that Ignatieff's estimate (eight miles long) fell far short of the reality, although the enormous extent of the glacial stream was not made fully evident till the next year's exploration. The bed of the valley beyond the glacier has an extremely slight incline, and throughout its upper course, with an average breadth of a mile, it forms a shingly desert, completely levelled in by its covering of detritus, through which the mighty stream ramifies irregularly. Despite this distribution of its volume the crossing is difficult, as each branch still has a deep bed of considerable breadth—in fact, a copious and rapid stream. Where these waters unite in a single arm, at certain reaches of the middle course, the crossing is possible only in the early morning. As during the next year I ascended

Digitized by Google

the valley through its whole length from its confluence with the Sary-jass to the Tys-ashu pass, and as in the later part of this report I shall have to deal with the observations then made, I will confine myself for the present to a few details of the physical features of the upper course.

Here also basin-shaped expanses up to a breadth of two miles are met with. Such a tract, some thirteen miles below the lower end of the glacier, is blocked by a low ridge of limestone schist cliffs, forming a barrier, which with a length of nearly two miles, stretches obliquely across the bottom of the valley, here some two miles wide, so that an opening of not more than about 500 ft. (150 m.) is left for the outflow of the waters. On the extremely disturbed and dislocated rocks of this old barrier there still lie the remains of old ground moraines. In this valley, too, the old glacial deposits acquire quite an extraordinary development. On the descent from the Tys-ashu pass we already meet with them here and there, 1,000 ft. (300 m.) below the level of the pass—that is, 2,000—2,300 ft. (600—700 m.) above the bottom of the valley—and in like proportions they are seen along the downward course of the valley. Hence nearly all the mouths of the transverse valleys stand very high above the present bed of the main valley. Of these transverse valleys, however, only a very few occur throughout the whole middle and lower course of this long river-bed. Owing to the rapid change of climate after the retreat of the lateral glaciers in the post-

Digitized by Google

glacial epoch, erosion had no longer produced any great effects in this district, as I have already shown by other examples (*vide* pp. 85, 45). In the Inyeklch valley also, as in the other large longitudinal valleys and for like reasons that have already been discussed, the imposing Alpine character is confined to the southern flanking range, at least in the ice-free part of the valley.

In the upper course all vegetation, except a rubble flora, is banished from the bed of the valley, and confined to the slopes on both sides, where, however, it is displayed in the sharpest contrasts. The slope on the right bank, facing southwards, is treeless and scrubless, and only the lower part covered with thin stunted, grassy growths, which assume the aspect of meadows only in a few tracts, sheltered from intense insolation by the disposition of the slope. On the other hand, the slope on the left bank, facing northwards, is decked with bright Alpine meads, and strangely contrasting with the woodless Sary-jass valley, even shows somewhat dense patches of pines. This is all the more remarkable since the Inylchek valley, although it has the same trend as the Sary-jass valley, lies considerably farther south, and according to my meteorological records is distinguished by greater dryness of the atmosphere; while on the other hand, in the Sary-jass valley even the slope facing southwards is carpeted with lovely Alpine meadows, which are missing in the parts of the Inylchek valley, enjoying the same aspect. On the contrary, on the southern slopes of the Inylchek valley pine-

Digitized by Google

groves are met with, wherever the least mountain débris has been brought down from the steep rocky walls of the valley and deposited in cones at the foot of the cliffs, or where morainic drift lies on banks and terraces. The discrepancy of these relations cannot be explained by the nature of the soil, since the constituent elements of the mountains are of much the same character in both valleys. For a distance of about twelve miles on the same side of the valley a green zone stretches from the end of the glacier tongue along the foot of the rocky walls far up in the frigid zone. Short Alpine grasses, a rich Alpine flora, and, besides other bushy plants, the Caragana shrub (Siberian Pea-tree) of dense forest-like growth, form the chief components of this pleasant floral zone, which extends right up to the region of perennial frosts and is associated with old lateral morainic drift.

Strange to say, for about the same distance (some twelve miles) the glacier is covered across its whole average width of about two miles by a mound of morainic débris and large boulders at least 450 ft. (100 m.) high. By atmospheric influences, by the erosion of the waters and by the movement of the glacier, this mound has been disposed in ridges and peaks of the most diverse forms, valleys, troughs, cauldrons—in a word, every form developed by a real mountain range. The material for this work has for the most part been supplied from the slopes of the chains skirting the main valley and from those of its ravine-like lateral valleys, which along the lower course of the glacial stream are

Digitized by Google

free from ice up to a considerable height. Owing to the extraordinary fluctuations of the temperature in this valley, and its southerly position, the disintegration of the rocks has been carried to an unusual extent, while the material entering into the structure of the mountains, here mainly schists, offers but slight resistance to such influences. Still, the climatic conditions alone could not have caused such great effects, had they not been supplemented by the incredible disturbance of the strata. Here we are in a region of the most profound and manifold dislocations, which are exposed in many places on both sides in the cliffs, skirting the lower course of the glacier.

That seismic movements, however, have not yet ceased in this region was shown by an earthquake, which occurred on the morning of August 22nd, 1902, lasting about half a minute, and making itself felt in three very severe shocks, proceeding from below upwards. A fearful, never-to-be-forgotten spectacle was presented as an immediate result of this disturbance on the precipitous glaciers of the gigantic mountain above described, at the foot of which we had established our headquarters. Huge masses of ice were set free, and came tumbling down with an indescribable crash into the gorges of the huge rocky buttresses, from which great columns of powdery snow and ice then rose up to the level of the snowy crests of the great mountain.

The mound of detritus, piled up on the glacier is so compact that ice crops out only at the edges,

Digitized by Google

so that the ice-stream, although it descends lower than the Semenoff, is thus prevented from thawing, despite the fact of its penetrating far into a southern climate. As the melting waters are forced to seek an underground outlet beneath the overlying drift, they excavate rudimentary crevasses at the end of the glacier, scooping them into hollows, where the water is then collected. On the advent of the warm season the pent-up waters seem to occasionally burst their fetters, and discharge themselves with irresistible force over the plains, carrying with them huge masses of ice. Even so late as the end of August in the year 1902, and at a distance of two miles from the glacier, I came upon several blocks of ice as big as a house in the boulder-strewn Inylchek valley, exposed though it is to such extreme insolation. The only explanation I can offer of such a phenomenon is that above suggested.

A visit to the glacier in two successive years enabled me to determine the altitude of its lower end, at about 10,500 ft. (3,200 m.). There were no indications at all of any recent retreat of the frozen stream. Its stability is sufficiently explained by its enormous development, its slight incline—only about eighty feet per verst—and compact morainic covering, which itself stands in close relation with the slight incline.

This mound of detritus necessarily makes the exploration of the lower section of the glacier extremely toilsome and fatiguing. In a day's march one can cover only a few miles. Being

Digitized by Google

unmindful of this circumstance, and also unprepared for the vast dimensions of the glacier from the hitherto published reports of its magnitude, and moreover unaware that at this season the valley is not even visited by the nomad Kirghiz, I had not brought sufficient supplies to meet the wants of the party for eight or ten days, the minimum of the time, required for profitable work on the glacier. The number of porters was also insufficient for such undertakings, while these fellows themselves struck work at critical moments, and broke out into open revolt against me. Under such circumstances I was fain to confine myself to a short excursion in the region of ice.

The expedition separated into two parties. Herr Keidel descended the valley with a small party in order to make a survey of its geological structure, and with a view to acquiring some knowledge of the local conditions, he pushed on to the next large parallel longitudinal valley, the Kayndy valley, which lay to the south, but was still entirely unknown, and not even figured on the maps. As I next year explored this valley and another, stretching still farther south, information regarding them will be found in the later parts of this report.

Herr Pfann and I plodded across the morainic mound of the glacier, making very slow progress. After covering about two miles, we saw, rising behind the heap of drift, a broad, massive rocky wall, dark, but capped with nevé. Much farther on, where

Digitized by Google

the ice begins to be free from débris, this rampart divides the wide glacial stream into two branches. When we got a little higher up, a bright, slender pyramid was seen towering into the air, but much farther back, at the side of the dark mass and close to its northern flank. We at once recognised it as the summit of Khan-Tengri. Owing to a peculiar bend in the axis of the valley and in the trend of the range, of which the dark rampart evidently forms part, the interesting picture seems to the eye shifted in such a way that the observer remains uncertain as to the grouping of the mountain ranges and the position of the breach, from which rises the pyramidal peak. A few hundred steps farther, and this peak is no longer seen at all. Still, there was great probability that it must stand somewhere in the Inylchek valley, or in one in some way connected with it. In order, therefore, to get a better insight into these relations, we decided to make our way over to the left side, bivouac there on the edge of the glacier, and ascend a lofty summit, rising above the border-range. From such an elevation we hoped to get a clear notion, regarding the trend of the ranges along the valley and the position of Khan-Tengri, and to be able also to take telephotographic views, since the unfavourable circumstances, already mentioned, prevented us for the present from penetrating farther into the mysterious glacial region. Leaving the execution of this project to Herr Pfann, I undertook to investigate the complicated disturbances in the structure of the range;

Digitized by Google

these can be best observed in the fine exposures of the steep walls on the right side of the valley.

However, the extremely crumbling state of the schists forming the rocky crest of the mountain to be scaled, together with the treacherous constitution of the upland snow, prevented Herr Pfann from reaching the summit. During the ascent atmospheric disturbances also set in, so that very little remained visible of the mountain ranges, A strong atmospheric pressure now prevailed, heralding snow-storms. To my deep regret I had in all haste to quit the valley, which I had so hastily explored, and of which I had seen so little; but there was no option if my retreat over the pass was not to be cut off by the snow. Not till the next year, when I returned better prepared, was I successful in unravelling the mystery of the conformation of this valley, on which more details will be found in the later parts of this report.

Here I should like just to draw attention to a peculiar phenomenon in the climatic relations of the valley. During the five days of my sojourn in it, there regularly sprang up in the later hours of the afternoon whirlwinds, which carried aloft considerable quantities of dust from the ground and again deposited them as loess on high-lying ledges and little terraces in the walls along the margin of the glacier. Extensive banks of this aeolian precipitation may be observed, especially along the left edge of the glacier.

Digitized by Google

CHAPTER V

FROM THE KAPKAK VALLEY TO THE GREAT MUSART VALLEY

On our return from the Tys-ashu to the Sary-jass valley Herr Pfann and I left the caravan, and ascended the above-mentioned dividing ridge between the Kusgun-ya and Tys-ashu groups of valleys, the Tur plateau, about 12,300 ft. (3,750 m.). Here we saw the pyramidal peak of Khan-Tengri, rising above the surrounding ranges far more boldly than from any of the other, even higher points hitherto visited. The ranges, however, as seen thence, seemed to be shifted in quite a peculiar way, so as to give the impression that Khan-Tengri rose at the head of a valley with a north-easterly trend towards the Musart pass, or a little to the south of this point, but at its origin apparently connected with the head of the Inylchek valley. The view was sketched and photographed, which took up so much time that we had to pay for our exploring zeal by an exposed bivouac without shelter or provisions, and did not overtake the caravan till the following day, after crossing the Kapkak pass, about 12,150 ft. (3,700 m.), in the valley of the same name.

Digitized by Google

This valley, running some forty-three miles in a south to north direction, is amongst the most important transverse valleys along the upper course of the Tekes. The Kapkak pass lies at the converging point of four valleys, as owing to a lateral thrust (*Vorwerfung*) the ranges here diverge widely from each other. For this reason the Kapkak river, with its large and widely ramifying affluents, effects the drainage of a very extensive territory. The trip across this charming valley ranks amongst the most enjoyable excursions in the Tian-Shan. All the elements that combine to form a romantic Alpine dale are here represented in the greatest profusion. The pine forests are magnificent, and contain trees of gigantic size. The development of the Alpine flora is, next to that of the Mukur-mutu valley, the richest and most luxuriant that I have seen in the Tian-Shan, while the growth of Alpine grasses is astonishing. Phyllites, granite, syenite, fossiliferous limestones, and calcareous slates form the geological structure, which resembles that of the Bayumkol valley, but owing to the disturbances, that have here taken place, presents in many respects a special interest.

For the study of the later vicissitudes of many Tian-Shan valleys the Kapkak basin offers some special features, particularly in its lower course. Although at its head nevé and ice are at present quite insignificant, every indication of complete former glaciation may here be observed. In its upper course ancient moraines acquired an immense

Digitized by Google

development, and in its lower course the masses of fluvioglacial rubble have in some places been deeply eroded by the river. Its course, which formerly lay more to the east, having been shifted by the resistance of such boulder deposits or by the ice, the stream has been compelled, in order to reach the Tekes, to eat its way through a mighty barrier of hard limestone in a steep impenetrable canyon. The waters, formerly dammed up by glacial drift, have flooded basin-shaped expanses, thus forming lakes. The side-valleys which debouch here lie very high. They have been eroded in trough-like form, and although formerly enclosing small lakes, are now empty, while their mouth lies high above the beds of the former lakes of the main valley. Reasons for this disposition have already been several times dwelt upon (*vide* pp. 35, 45, 69). Later irruption of considerable bodies of running water may be assumed from the circumstance that loose younger conglomerates are found deposited, high above tertiary formations, like that lying on the borders of the old basin-shaped expanses of the Tekes valley. These deposits extend in places even beyond the tertiary to the limestones. Besides the tertiary beds we also see, exactly as in the Tekes valley and at other places, great quantities of sand and débris, which are derived from disintegrated and eroded granites. During the subsequent course of the expedition I visited the Kara-kul-say, one of the largest lateral valleys of the Kapkak, in which there is still a lake, dammed up by old moraines, and in which the

Digitized by Google

indications of those, already vanished, are well preserved (see particulars farther on).

Towards the end of August, after my return to Narynkol, I lost some valuable days there in exchanging the worn-out horses, and especially in procuring fresh "Jigits" and porters to replace the former, to whose refractory conduct is partly attributable the fact, that so far the journey had yielded such slight results. At last I was able, at the beginning of September, to return to the Bayumkol valley to resume the previous operations, interrupted by bad weather. I hoped to be favoured by more settled weather in the advanced season, when the contrasts of temperature between the plains and uplands are less pronounced. Unfortunately general atmospheric disturbances took place, again seriously impeding and delaying our work. For the same reason the intended ascent of one of the high snowy peaks at the head of the valley had to be put off. The only ascent was that of a granite eminence, about 14,450 ft. (4,400 m.), at the northern edge of the western glacier, from the top of which a panoramic view of the surrounding mountain ranges was obtained. Herr Pfann also, despite the unfavourable weather, was able to complete the survey of the western glacier, and to determine the height of the peaks of the border-ranges from an elevated basis. In the course of our wanderings in connection with these operations I came upon a breach about 14,000 ft. (4,250 m.), free from ice, in the ridge, which separates the Karakol river, flowing to the Sary-jass (see above)

Digitized by Google

from the basin of the western Bayumkol glacier; and here also I obtained a magnificent view of Khan-Tengri, appearing through a gap in the southern border-range. In this breach I found five decayed posts, jammed in between rocky boulders. At first I supposed they might have belonged to the Ignatieff expedition, and that the breach in question was identical with the gap, which this traveller named the "Narynkol pass," and which he states is 13,580 ft. high. After, however, again reading the passage in Ignatieff's report (*Isvestiya Russ. Geograph. Soc.* vol. xxiii.), I hesitated as to this assumption, because Ignatieff made the descent from the pass down to a glacier and traversed it lengthways on horse-back, which for the western Bayumkol glacier must be pronounced absolutely impossible. Nor could Narynkol be reached in one day from this glacier, as is asserted by Ignatieff. Lastly, the difference between our two determinations of height is so great, that these cannot have reference to the same position. Hence Ignatieff must presumably have crossed at some other point. The western Bayumkol glacier is formed by the confluence of five glaciers, issuing from recesses in the walls enclosing the valley, and is much broken up, especially in its middle course, and its upper nevé is likewise much crevassed. Here it communicates with the Semenoff glacier by a snowy saddle about 14,450 ft. (4,400 m.), which I reached the following year from the Semenoff (see below), and is also connected with the upper nevé

Digitized by Google

basin of the same Semenoff glacier by the Semenoff pass (see above). A connection also undoubtedly existed formerly with the Karakol glacier, and in the ice age all these glaciers evidently formed a continuous ice-field. At present the ridge between Karakol and Bayumkol is free from ice on the side (south-east), facing the latter valley, and here the sedimentary rocks (limestone, marble, clay schists) are seen lying finely exposed in several strata between the granites.

Unusually heavy snowfalls at last drove us (September 20th) from the uplands, where no fodder was any longer procurable for the horses. The snow already reached down to the Tekes valley, and I was fain to postpone till the next year all the explorations in my programme on the north side of the highlands, and cross over to the south side, where more favourable conditions might perhaps permit of more protracted operations.

Digitized by Google

CHAPTER VI

NORTHERN MUSART VALLEY, MUSART PASS, AND SOUTHERN MUSART VALLEY

After a few days' preparatory work, the expedition left Narynkol on September 23rd, in order to surmount the Great Musart pass, which had already been traversed by a few Russian expeditions. Von Kaulbars has published some notes on the topography of the district, and Ignatieff on its geology. I shall, therefore, in this report limit myself to some hitherto only partially known or quite unknown particulars, reserving for the more detailed account of the journey a series of physico-geographical observations, for which the crossing of this pass afforded ample opportunity.

The downward route from Narynkol through the Tekes valley leads through one of the best-defined basins of the old frontal lakes which formerly lay at the base of the mountain range. On the southern border the outlines of the old terraced beaches have been excellently preserved. At the wide entrance to the Musart valley beds of fluvioglacial deposit form five ancient terraces, and for several miles, follow the course of the valley as longitudinal banks, nearly up to the foot of the mountain mass.

Digitized by Google

Here, in the vicinity of the first Chinese military post, where the copious Musart river emerges from the highlands, it is joined by its equally copious affluent, the Dondukol (on which more below). The united stream is not easily crossed, and through the carelessness of a "Jigit" during the passage, the expedition met with an accident of far-reaching consequence. One of the packhorses stumbled, and his load—two tin boxes bought as "air-tight"—fell into the water. When fished out, the contents were found thoroughly saturated. Amongst them were a great number of large, exposed "Edward films," shut up in tin boxes, which were supposed to be "absolutely air-tight." Relying on this, we omitted to open them immediately after the mishap, and when we did so later on, it was found that water had penetrated through, destroying all the films. Sixty views, 6½ by 8 English inches in size, mostly panoramas and telepanoramas, taken from lofty positions, the fruits of indescribable toil and care, the main result of the summer's photographic operations, geographical documents of priceless value, were irreparably lost. By this disaster the course to be followed by the expedition in the next year was in a way already marked out. Records so important for the topography of the Central Tian-Shan, could not be dispensed with. It was necessary above all to revisit the more conspicuous points, from which the lost photographs had been taken. However keenly felt the damage was at the time, still it proved beneficial in the end.

Digitized by Google

Being compelled again to retraverse the uplands already visited, and being then also more familiar with all the local conditions, and moreover favoured by good weather, I was able in the following year to work better and more successfully than in the first summer, and in most cases to find the solution of what had hitherto puzzled me in the structure of the Central Tian-Shan.

At the entrance of the Great Musart valley is seen a vast series of chloritic schists, often interstratified with phyllitoid schists. Just before emerging from the highlands, the river breaks through masses of red granite, which are followed higher up by a narrow zone of gneiss. But aphanites are soon developed over a wide area, and farther up the valley, where they again approach a granite stratum, they assume more and more the character of schists. These schists, with an almost northerly strike (N. by 10° E., which for this region is abnormal), have been thrown into irregular narrow folds. Pressure-phenomena occur also in the granite, which not infrequently assumes the form of granitic gneiss. Limestones and clay-slates, cropping out between the granites, have, owing to dynamo-metamorphic processes, been pressed, the former into schistose, the latter into crystalline forms. More regular conditions do not appear till far back in the valley, where a normal easterly trend (N. by 7° E.) is resumed. Here the granite occurs under very diversified forms, even as porphyritic granite, and in some parts is replaced by syenite. Over a somewhat wide

Digitized by Google

zone it is followed by gneiss and other crystalline schists. Yet the nearer we approach the head of the valley the more prevalent become dark, more or less crystalline limestones, clay-slates, and marbles, from which, as in the other large valleys, are exclusively built up the sections of the crests, belonging to the main water-dividing range. Here, however, also occur great masses of dolomitised limestones, which present the same bold and fantastic summits as we are familiar with in the dolomitic limestone highlands of South Tyrol, and under these forms they flank the defile of the Musart pass southwards throughout nearly its whole length.

The Great Musart valley, as far as it lies within the highlands, has a length of from thirty-six to forty miles, and is distinguished from the other large Central Tian-Shan valleys by the somewhat steeper incline of its bed (average about ninety to ninety-five feet per mile). At the outlet of the river from its narrow upland course, about 6,200 ft. (1,900 m.) great quantities of fluvio-glacial drift are deposited on both sides of the valley, where they form terraces (*vide* p. 28). At the confluence of the Dondukol (not Maralta, as it is wrongly called by Ignatieff), which here joins the main stream at an obtuse angle, these terraces either intersect or are piled up against similar formations deposited by this affluent. Like other Tian-Shan valleys, that of the Great Musart is likewise disposed in basin-shaped expanses, which are connected by gorge-like narrows. These narrows are for the most part

Digitized by Google

choked by old moraine deposits, through which the river has everywhere cut itself deep channels, which, however, rarely reach down to the bed-rock. In the basin-shaped expanses the moraine débris is found deposited for the most part on the left bank in step-like terraces, rising one above the other. During the ascent the traveller wanders along the picturesque valley on the slopes of the left bank, decked with magnificent pine groves, especially in the middle course, exclusively over Alpine meads and forest-bearing old morainic soil. In several places the old terminal moraines are of enormous dimensions. At the confluence of the Khamer-davan, about 7,900 ft. (2,400 m.), of which more farther on, lies the largest of these beds, which has a width of nearly two miles and forms a huge mound in the valley. Another nearly as large lies about seven miles higher up, at an altitude of some 8,400 ft. (2,600 m.), and still maintains a height of 250 ft. above the level of the valley. The morainic drift is conspicuous to a considerable height on the walls of the valley, while ice-worn rocks and *roches moutonnés* may be observed on the face of the cliffs. Here also, besides several deeply eroded lateral valleys of ancient origin—Dondukol, Khamer-davan, Atunbulak, etc.—one can distinguish a series of high-lying trough-shaped, younger valleys with cirques at their heads, and the mouths of which are raised high above the present bed of the main stream, thus indicating the former level of the chief glacier, which once filled up the whole valley. They still

Digitized by Google

retain small glaciers. A peculiar phenomenon in this wind-sheltered valley is the deposit of loess-like beds of considerable thickness (fifty to sixty feet) on old morainic terraces. They appear to be formations of fluvial origin, although showing a resemblance to aerial loess. About half-way up the valley there occur hot springs (48° C.), near which the Kalmuks have built some primitive huts, while utilising them as medical baths. They well up in the valley-bed at the level of about 8,400 ft (2,550 m.), in the zone, where crystalline schists and granites come in contact with greatly disturbed limestones.

At the point where the valley-bed describes a semicircular curve of short radius towards the east, the range on the right bank, apparently shutting in the valley, rises to a series of bold lofty peaks, about 18,000 ft. (5,500 m.), which, owing to their northerly exposure, tower with their fronts completely enveloped in snow and ice, superbly above a darkly-wooded old moraine. At their foot the wildest of the big glacial streams, that I have seen in the Tian-Shan, bursts out from a lateral valley, coming from the east, and is dissolved into a series of wonderful cataracts, with thousand-fold *seracs*. This glacier on reaching the bottom of the main valley turns northwards, and ends at a height of 9,000 ft. (2,750 m.), a little above the third Chinese post, where it is separated from the main stream by a huge lateral moraine, which it has here deposited. Judging from the height of this morainic ridge (up to 200 ft.), from the

Digitized by Google

immense size of the boulders, consisting exclusively of light dolomitic limestone and marble, and from the great thickness of the ice at its tongue, this still unexplored glacial stream must be of great length. Beyond doubt it has its source at the dividing ridge, by which the head of one of the upper affluents of the Agiass, which flows north to the Tekes, is separated from the Musart valley. From there also—that is to say, from the main crest of the Khalyk-Tau in the east—stretch the dolomitic limestones and marbles, composing the above-mentioned lofty snowy peaks, and abutting here on the granites and gneisses. The protection, afforded by this rampart with its northerly face, has secured an exceptionally mild climate to the part of the valley, lying behind, despite its great elevation (9,200 ft.; 2,800 m.) The result is seen in a wonderfully beautiful bush and forest vegetation, ranging right up to the glacier ice.

The Musart pass is a "wall-pass," whose irregular flat top has an extent of over ten miles. From the north side, the ascent, which starts from the elevated terraces at the head of the northern Musart valley (about 9,500 ft.; 2,900 m.), is short and steep up to the plateau; the descent to the south, down to the Tamga-tash post (about 9,050 ft.; 2,760 m.) is long and gradual, excepting a few steep steps, so that the two sections are unlike. An anomaly is seen in the fact that the glacier on the north is short, while that on the south side is very extensive. The Yalin-Khanzyn glacier,

Digitized by Google

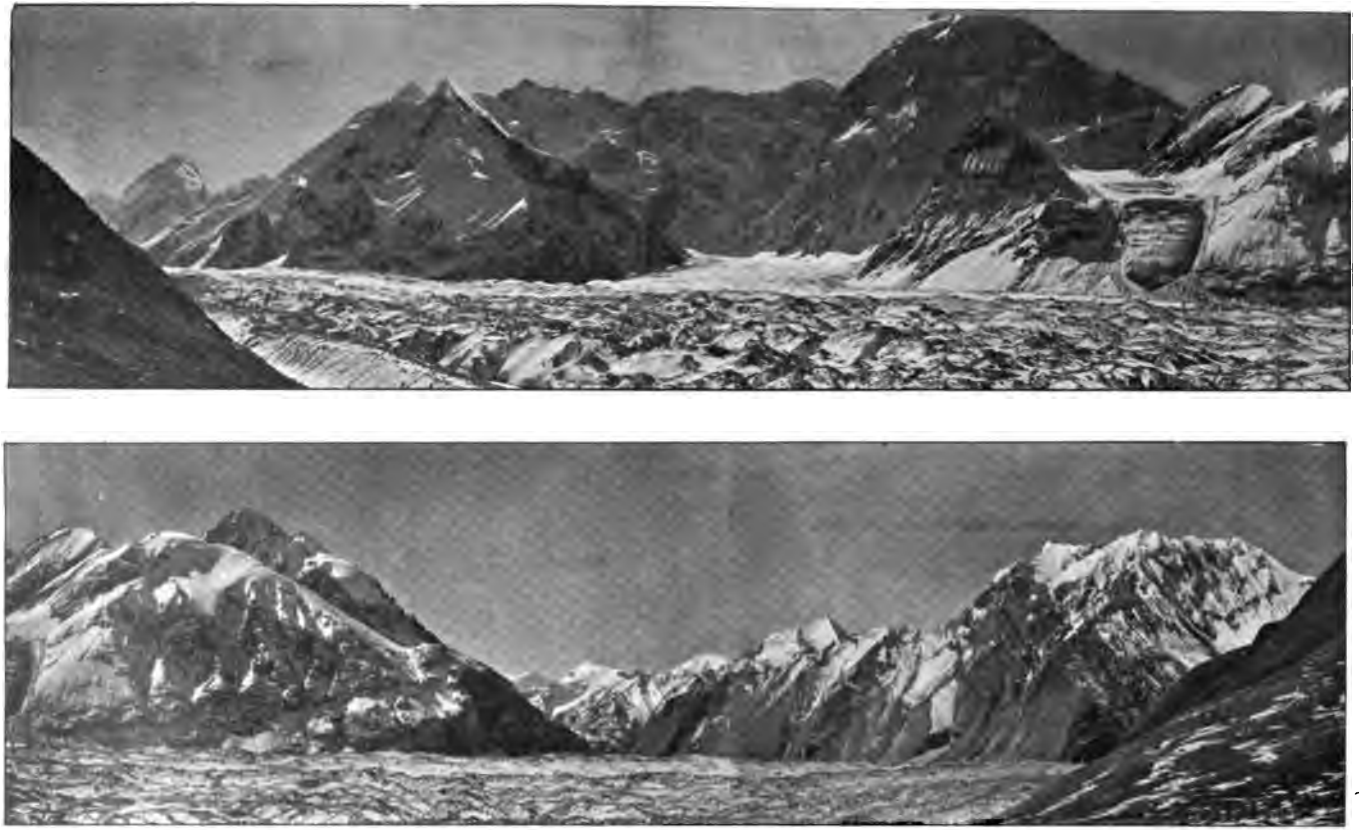
descending northwards, is now merely an insignificant remnant of a formerly extensive ice-stream. It terminates at a level of about 10,200 ft. (3,100 m.), and is almost entirely covered with detritus, so that a little ice is visible only at the confluences of small lateral glaciers. The watershed between it and the Jiparlik glacier, descending southwards, is almost obliterated. Owing mainly to the very shifting accumulations of morainic drift, it is difficult to determine the culminating point of the pass. We considered this to coincide with a small plateau, whose altitude was calculated by a preliminary survey at about 11,480 ft. (3,500 m.). Ignatieff's figure is 12,240 ft. (3,730 m.).

Near the top of the pass on its southern slope the mighty Jiparlik glacier descends from the east-north-east. The glacial stream where it covers the highest plateau of the pass is nearly free from débris, and over a slightly inclined stretch of several versts the surface ice is divided into millions of tiny, tent-shaped knolls, the origin of which is to be attributed to peculiar melting processes. As far as the eye can penetrate up the course of the glacier, from 300 to 400 m. or about 1,200 ft. broad, high snowy mountains (limestone and marble) are visible along its margins. But owing to a bend in the valley the source itself cannot be seen. It seems to lie in the same dividing ridge as the already mentioned large glacier, which joins at the bend of the main stream. Near its outlet on the plateau of the pass, an arm of the chief glacier, branching off to the south-west, stretches obliquely

Digitized by Google

across the plateau, and disappears in an opening facing the south-west in the wall of the west margin. The main glacier itself trends, with an average breadth of one and a half miles, first south-eastwards, then southwards, and terminates at a height of about 9,500 ft. (2,900 m.) in a tongue (now rapidly retreating) above the Tamga-tash post. Here a waterfall bursts out through a gate-like aperture in the ice-wall. At the time of my visit, above the lowest cavity were still to be seen two other, quite similar but empty cave-like outlets, standing one above the other in the terminal wall of the glacier. Hence the stream had evidently cut its bed deeper and deeper in the ice. Its waters had once been dammed up in a morainic lake about two miles long and one mile wide in front of the glacier. As far as the glacier covers the plateau of the pass on its gently inclined southern slope, the ice is almost hidden by a coating of débris; where it shows itself it is beset with a very large number of funnels, in each of which lie one or more large boulders, whose great absorption of heat gave rise to these hollows. On the rocky enclosing walls, over 3,300 ft. (1,000 m.) high, the traces may everywhere be noticed of the grinding force of the glacier ice, indicating how it formerly completely filled the upland valley. On the left bank, at the foot of an ice-polished marble wall 1,300 ft. (400 m.) high, the ruins of a *mazar* and of the Mazar-bashi post stand on a rocky, gently inclined terrace. At this point, where a lateral glacier debouches, the main glacier breaks with a

Digitized by Google



JIPARLIK GLACIER, TAKEN FROM NEAR THE MUSART PASS (ABOUT 11,500 FT.).

[*To face p.* 90.

Digitized by Google

Digitized by Google

fall of about 350 ft. to a lower terrace, where its glacial masses are dissolved in wild *seracs*, horns, and pinnacles, separated by yawning chasms. This is the famous passage which has been a terror for hundreds of years, and cannot be surmounted by the caravans without the aid of the guards at the Tamga-tash post, who have excavated regular staircases in the icy pinnacles. But the skeletons of pack-animals, strewn about in large numbers, show how great are the perils of the passage, despite all aid. Nevertheless, this pass is still relatively the easiest for communication between the north and south sides. A caravan, floundering amid this maze of icy turrets presents a strange spectacle. At the foot of the succeeding glacial terrace an extensive lake occupies a hollow in the ice near the left bank. The whole length of the Jiparlik glacier cannot be estimated at less than sixteen miles.

It has already been pointed out that dolomite limestone, carved into exceptionally bold peaks, together with white marble, forms the prevailing constituent of the ramparts, flanking the Musart pass. These light-coloured masses stand in sharp contrast with the dark jagged walls of highly metamorphosed eruptive rocks, which uninterruptedly accompany the metamorphic sedimentary beds from the head of the defile in the north down to its southern end and far beyond it, both sets of strata sharing in the later contortion, of which extraordinary instances are here and there grandly exposed. Owing to the prevalence of a north-easterly trend with a marked incline to the east,

Digitized by Google

gneiss and syenite are noticed only on the north side of the pass.

The route through the southern Musart valley, which has a length of about sixty miles, with a breadth of from one to two miles, presents great interest in two respects. In the first place, there are the tremendous dislocations, to which not only the igneous rocks (gneiss, granite, syenite), but also the sedimentary formations, have all been subjected, and then the great masses of eruptive rock (diorite, porphyrite) which have burst through both series. A more careful study of the conditions observed will be needed, before it can be decided whether the disturbances were in the first instance caused by the intrusive igneous rocks, and hence were to a certain extent local, or whether the whole *massif* was affected by wide-ranging convulsions, followed or accompanied by the intrusion of the magma in the chasms thus formed. Here, too, as is so often the case, the zone of contact awakens the deepest interest. Extensive metamorphic phenomena are seen, not only in the contact zone of the erupted matter with the sedimentary and old crystalline rocks, but also where these two are found associated together. During our second visit to the valley, Herr Keidel made a complete collection of specimens from the contact zones.

In the southern Musart valley granite, syenite, gneiss, etc., occur, only at greater distances from the central ranges than in any of the northern and southern transverse valleys, visited by me—that

Digitized by Google

is, only in the outer section of the valley, up to where sedimentary rocks alone enter into the structure of the highlands. Gneisses are far more extensively developed than had hitherto been supposed. Between the Khailik-Mabuse and Tograk posts they form an uninterrupted zone three miles long, sharply limited at both ends. Chloritic and highly metamorphosed schists are interstratified with granites. The limestones too, occuring here, became more or less crystalline. The walls of the ranges, running obliquely to the trend of the valley, often perpendicularly cut to a height of 4,900 ft. (1,500 m.) and more, show in their strata the most remarkable and diversified bendings, crumplings, and foldings of the vertically disposed sedimentary beds even down to the minutest wrinkles, with exposures on the grandest scale, and always most pronounced in the neighbourhood of intruding dioritic rocks. In some places the intrusion of the magma is in dykes, accompanied by extensive apophysic formations. Despite the dynamic effects, accompanying the powerful dislocation of the sedimentary beds, Herr Keidel succeeded in finding a limestone bed that had been spared, and in it collected a fauna belonging to the upper carboniferous age. This justifies the conclusion that these limestones of the middle and lower valley, and the crystalline masses between which they rest, are from a tectonic point of view to be separated from the older palæozoic limestones of the head of the valley and from the metamorphic eruptive rocks, folded together with

Digitized by Google

them. Old crystalline conglomerates begin to occur in the second section of the valley, but do not appear in larger masses till near its outlet, where they are associated with sandstones and metamorphic schists between the lateral Ak-topa and Moro-khotan valleys. Exposures in walls 1,800—1,600 ft. (400—500 m.) high also reveal in these conglomerates extraordinary strains and twists in the strata. The great pressure is attested by blocks of conglomerate, which are strewn about, and whose constituents have been crushed out lengthwise. These conglomerates also form the slope of the range, facing the valley of the Musart-daria, flowing to the east, of which more farther on. A few miles beyond, where we struck south from the Musart, sandstones again occur on the slope of the range facing the steppe at the mouth of the Kash-bulak valley. These are compressed in close folds together with coarse, schistose-calcareous and fine conglomerates like grauwacke, and in places contain fractured, laminated, shiny carboniferous clay slates (*Lettenkohlenschiefer*), elsewhere even real anthracite.

No less interesting than the peculiar geological features of the Musart valley are the indications of its former extensive glaciation. If in this valley, trending southwards, the old morainic deposits are seen in much larger quantities and less destroyed than in the great glacial valleys on the north side, the explanation, as already rightly suggested by Ignatieff, is that in the north, owing to the very extensive glaciation, which to a considerable extent

Digitized by Google

even now continues, the old masses of boulder drift were for a long period, and are to the present day, exposed to the vigorous erosive action of the melting waters. Here in the south, on the contrary, where the present glaciation is relatively slight, the climate much dryer, and in any case, even in the post-glacial period, was subjected to more rapid changes than in the north, the destructive and obliterating forces were less effective in the interior of the valleys.

Here we see first of all that in some places the valley was blocked by old frontal moraines, and elsewhere by the accumulation of diluvial deposits at natural constrictions, forming six basin-like expanses, which represent so many former lakes. In the second basin, morainic drift lies on high terraces, from 1,000 to 1,300 ft. (300—400 m.) above the level of the valley, while scorings on the surface of the rocky walls here, as farther out in the valley, extend considerably higher up. In some places, as in the fourth basin, the foot of the mountain barrier is literally buried in morainic drift up to a considerable height, and this débris forms, for a distance of one and a half miles, a compact covering of the broad channel of the valley still over 200 ft. thick, although much of it has already been swept away. There, dry weathering has reduced the boulders (marbles, limestones) to sand and dust, above which the still remaining blocks partly project. By these products of weathering a long stretch of the valley has been transformed to a

Digitized by Google

real sandy desert, whose dune-like eminences are bound together by plants of genuine desert type. The finer particles have been borne aloft and deposited as loess on elevated terraces, where they often attain a thickness of from forty to fifty feet. At the Khailik-Mabuse camping-ground, about 8,130 ft. (2,480 m.), old morainic drift rises some 1,300 ft. (400 m.) above the level of the valley. But the greatest accumulations are found in the neighbourhood of the Tograk post, about 7,700 ft. (2,350 m.), where exceptionally large masses of drift have been deposited by the Tograk-Yailak, which joins on the right bank. These were heaped up on those of the chief glacier, whereby the detritus was raised to the enormous height of from 1,600 to 2,000 ft. (500—600 m.) against the opposite mountain wall. Here the valley is blocked by a barrier of morainic débris some 650 ft. (200 m.) high, through which the river cuts its way in a romantic gorge several miles long. While on the moraines, so far described, the boulders consist of marble and limestone, here scarcely any but gneiss blocks are seen, which aeolic excavation (corrugation) has fashioned into thousands of fantastic forms. Below Tograk the lateral Jin-Jilga valley joins on the left side, and from the confluence the gigantic ground-moraine of the old glacier projects in excellently preserved form far into the main valley. The immense masses of shifted débris, however, cannot be derived from this lateral glacier alone, since they extend as a rampart a distance of six

Digitized by Google

to eight miles downward from 130 to 160 ft. above the level of the river, which has cut its bed deeply into them. The conformation of the mountain range here indicates rather that the gigantic glacier, which has deposited all this detritus, once overflowing the left, here greatly depressed, scarp of the valley, descended from more elevated parts of the. Khalyk-Tau in the east. At the last post also (Koneshar, not Kunya-Shar, as it is called in the forty-verst map) the main valley, about 6,900 ft. (2,100 m.), was blocked by morainic drift, which on the left side envelops the mountain walls some distance up.

That the old glaciers also extended out into the plain is shown, not only by the morainic mounds, which lie at the foot of the range, where it bends towards the east, and which were crossed the next year by the expedition on the route along the Khalyk-Tau (on this see below), but also by the enormous deposits of shifted glacial drift, including boulders, which to a thickness of several hundred feet still extend for over twenty miles out into the plain, here partly forming closed plateaux, partly disposed by erosion in little ridges of manifold shape. I must here lay stress on the fact that these last-mentioned deposits differ in some essential features from those formations for which M. Bogdanovich has introduced the term "Kuren" (*Trudi Tibetskoi Expedizii*, p. 88 *et seq.*). These masses have been preserved in a region, where erosion, dispersion, and denudation have operated more vigorously than in most other

Digitized by Google

lands. Granite boulders I found strewn over the desert more than twenty-six miles distant from the foot of the mountains.

The lateral valleys of the southern Musart valley, whose parched soil is traversed by a potent stream from which it no longer derives any appreciable fertility, still contain a considerable store of glacier ice, where rise lofty and magnificently glaciated ranges, the most superb and richest in glaciers being in the Turpal-che valley, in the cirque-like Chiran-toka valley, in the Serakh-su valley, Tograk-Yailak, etc. Into these valleys the pinewoods also have retreated from the almost dried-up main valley, and where they appear, present the finest contrast to the desert character of the main valley. In this we see one of the most remarkable upland valleys, remodelled by tectonic movements, and the action of ice, water, and wind, a juxtaposition of steppe and desert amid grandiose Alpine surroundings. Many other physical features would have still to be dwelt upon to complete the picture. But this would exceed the limits of this preliminary report.

Digitized by Google

CHAPTER VII

FROM THE MUSART VALLEY TO KASHGAR

Our intention to continue our work a little longer in the highlands of the great lateral valleys of the southern Musart river could not be carried out, as the valley offered no supplies, either for our men or the pack-animals. Hence the expedition could only be regularly provisioned from a station, lying far beyond the district, but for the organisation of such supplies there was no longer time at this advanced season of the year. The plan was therefore postponed to the spring of the next year, and we took the route, which leads out of the valley to the town of Ak-su, and then for a stretch of about twelve miles, intersects the ranges of the Topa-davan tertiary uplands between the Lyangar and Abad posts.

As I am not aware of anything, having yet been published on these uplands or altogether on the tertiary formations at the southern foot of this section of the Tian-Shan, I may here give some details on the subject. In the structure of the Topa-davan range the same red sandstones are exhibited, that we meet with in the tertiary of the Tekes plain and elsewhere, besides red, salt-bearing clays and marls, with gypsum-bearing

Digitized by Google

marls in some places, and lastly conglomerates of light and dark limestones. The whole *massif* has a general west-north-west trend, and in some places is distinguished by narrow intricate foldings. Although the mountains are in summer and autumn waterless, they have been carved into several ranges by the powerful erosion of running water, setting in with the melting of the snows and acting all the more vigorously on the mountain mass since it is built up of easily soluble materials, aided also by atmospheric influences, especially wind. The action of all these agencies is helped by the narrow foldings and the vertical disposition of the strata. By such forces these ranges have again been sculptured into a number of the most diversified crests, often affecting the most fantastic forms.

In these clay and marly uplands we again find, crowded together in a narrow, readily overlooked space, the same varied features in valley and hollow, the same manifold conformation of mountain and surface as are presented by the high ranges in wide inaccessible areas, of which we can obtain no comprehensive view. Many of the processes that there took place in a large way, have here been repeated on a small scale. In a word, the mountain-shaping and mountain-destroying forces have combined to produce a relief, which offers an instructive object-lesson on orographic structure, so far as regards the diversified character of the surface modelling. I later explored the tertiary highlands west, north,

Digitized by Google

and north-east of Kashgar, which are built up of similar materials, and also surveyed the Chul-Tau, a southern prolongation of the Topa-davan (on which subjects more will be found farther on); but however varied may be the articulation of the surface in some parts of those districts, it nowhere displayed such varied features as the Topa-davan. Its average altitude, rising gradually from east to west, is 5,250 ft. (1,600 m.). While the first foothills only reach a height of from 100 to 180 ft. above the almost table-like level surface of accumulated rubble, those approaching the south-west border rise to over 650 ft. (200 m.) above it. Here we are often surprised at the sight of perpendicular mountain walls, about 500 ft. (150 m.) high, which are formed of a single layer of clay, honey-combed like a sieve by the decomposition of easily soluble inclusions.

At the Abad post, about 5,100 ft. (1,550 m.), near the south-western border, there occurs a tortion of the axis, combined with a change in the trend—the ridges of the Chadan-Tau, which run from south-west to north-east, here converging with those of the Topa-davan, which run west-north-west. With this change are connected serious disturbances in the lie of the strata. Salt occurs especially on the south-west border in troughs and cavities in the form of efflorescences, which acquire a thickness of up to twenty inches, and are exploited by the Chinese. The mountains appear to terminate abruptly towards the desert, because the low ridges of the outer folds are completely buried

Digitized by Google

beneath a mass of detritus, several hundred feet thick.

The road from Abad through Jam to Ak-su may be passed over as well known. I also omit any remarks on the long stretch from Ak-su through Maral-bashi to Kashgar, although offering occasion for many interesting observations, since it has already been to some extent described by other travellers, as, for instance, most recently by Sven Hedin.

On October 18th, 1902, the expedition took up its winter quarters in Kashgar, from which place Herr Pfann and the preparator, Herr Russel, set out on the homeward journey. As the southern border-ranges of the Tian-Shan often remain free from snow even in winter, as was particularly the case in the winter of 1902-03, we ultilised this season, despite the intense cold, to make some excursions to that region, chiefly for the purpose of collecting palaeontological specimens. This object was also effected, thanks to the collecting zeal of Herr Keidel, and we returned to Kashgar loaded with rich spoils.

Digitized by Google

CHAPTER VIII

EXCURSIONS ON THE SOUTHERN EDGE OF TIAN-SHAN TO COLLECT PALAEONTOLOGICAL MATERIALS

THE first excursion led us to the Toyun valley, at first through the narrow gorges of the "Artysh strata"—made known by the publications of Stoliczka and Bogdanovich,—which attain so great a development at the southern foot of the Tian-Shan. Amid these profoundly disturbed strata lies a group of large villages which bear the collective name of Artysh.

In August 1902, not long before our arrival, earthquakes had almost utterly ruined both this and the other group, collectively known as Altyn-Artysh, which lies farther east on the southern border of the tertiary range, and was likewise visited by us. These places, now lying in ruins, presented a sad spectacle. For a wide space the ground was seen torn by rents and fissures, and in some places little mud volcanoes were noticed. In connection with these events the study of the "Artysh strata," as they are called, was of special interest to us. Later conglomerates, discordantly overlying these marly-clay and sandstone strata likewise exhibit indications of considerable dislocation. Even in very recent conglomerates,

Digitized by Google

dislocations were observed by us in several districts, especially in the Kurumduk valley, lying to the east of Altyn-Artysh. There can be no doubt that the seismic movements appearing in the upfolding of the Artysh strata, which are referred by Bogdanovich to the pliocene epoch, were continued in later formations, and persist to the present day (more on this in the detailed report). In the district, already mentioned, such movements led to the almost complete destruction of from ten to twelve populous villages which, standing on well-watered loess terraces, occupy the richest and most productive tracts in the neighbourhood of Kashgar. The epicentrum of the seismic forces nearly coincides with Artysh-bazar, and the destructive effects of the earthquake waves, radiating from this point, made themselves felt even in the city of Kashgar and its environs. We were able to follow these movements, somewhat weakened but still very destructive, over a wide area, up the Toyun valley, in the Maydan-Gess valley, farther east in the Kurumduk valley, and later even still farther east.

During our stay in Kashgar, more or less violent and destructive underground shocks were of such daily occurrence that one grew accustomed to them.

In the Toyun valley Devonian fossils were found, partly in the places already visited by Stoliczka and Bogdanovich, north of the Chou Terek grazing ground (not village), partly in other districts. On the whole, however, the finds were

Digitized by Google

not great, although we pushed northwards far beyond Yakub Beg's old fortified post of Chakmak. On the other hand, we ascertained the presence of erupted basaltic rocks in the zone of the most violent dislocations, in the schists and also in the sandstones, which are embedded in them, and are, by Bogdanovich, referred to the tertiary epoch, all at a considerable distance to the south of the localities, where they had been found by Bogdanovich (Suyok valley) and by Stoliczka (Chakmak); for further details see below.

During the following excursion our collecting work was more fruitful. The route led by Altyn-Artysh northwards, up the vast tertiary basin of Argu, which was formerly flooded by a lake and still shows well-preserved terraces. It was approached through a narrow portal cut into a rampart of conglomerate 650 ft. (200 m.) high, and was quitted by a similar outlet, leading into the Tangitar ravine, by which are reached the basin-shaped expanses of the former large lakes Tegermen and Arkogak, which follow from west to east, one a stage higher than the other. Stoliczka found some fossils north of Yakub Beg's barrier fort of Tangitar, consequently north of the gorge through which the river forces its way. The places where we made our great finds lie, some a little to the west of the old fort, some south of it. The fauna is probably partly Devonian, partly carboniferous.

Most surprising is the thickness of the conglomerates immediately before and beyond the

Digitized by Google

place, where the Tangitar river breaks through the carboniferous limestones in a romantic gorge from fifty to sixty-five feet wide, which winds for some two and a half miles between almost vertical walls, and escapes to the rocky Tangitar cirque. Although partly worn away, the conglomerates, in which are often embedded huge boulders, here rise in places up to 1,150 ft. (350 m.) above the level of the valley on the limestone walls, and project, as mighty buttresses far into the plain. Beyond the gorge, ancient valley terraces (*Längsstufen*) are seen in these conglomerates, which are over-lain by loess to a considerable thickness.

In the vast Tegermen basin, where no water now flows, except a narrow rivulet, deposits of shingle are of such enormous thickness that they partly hide the foot-ranges of the mountains, to such an extent that only a few of their cones and domes rise like islands above the overlying drift. In the left scarp of the basin Herr Keidel found upper carboniferous brachiopods, and in a narrow gorge Devonian corals. The bed of the extensive Arkogak basin, formed by level accumulations of rubble, is reached by a breach in the low range and over a broad sill of the soil. We followed the second basin a long way in a north-easterly direction. By a lateral valley, branching off to the east and draining indirectly to the Kurumduk river, access is gained to the extensive Bash-Sugun pastures of the Kirghiz. A bed of coarse, white limestone, containing a mass of excellently preserved fossils, was found

Digitized by Google

in the limestones of the ramparts, enclosing the Sugun valley, which are of very diversified character and exhibit complex stratified conditions. Here we were able to obtain a rich upper-carboniferous fauna of brachiopods, representing about fifty species in several hundred specimens. Bash-Sugun was already known from the fossils found by Stoliczka (E. Suess, *Contributions to the Stratigraphy of Central Asia*). But whether the locality, exploited by us, is identical with Stoliczka's seems doubtful when we consider that this explorer found only a few, apparently lower-carboniferous fossils in this place, whereas such an accumulation of organic remains as occurs at our "storehouse" could scarcely have escaped the trained eye of the distinguished naturalist.

On the further journey to the south-east through the Sugun valley, which here contracts and forms a series of small, cauldron-shaped expanses connected only by narrow passages, we noticed extensive intrusions of basaltic rocks in the form of domes, but also in dykes. Shattering breccias and conglomerates also occur, while the surrounding limestones have been greatly metamorphosed. The outbreak of basaltic rocks, ascertained by us as occurring in this region, as well as in various localities on the extreme southern border of the Tian-Shan, show that their intrusion is not confined to the line of fault, assumed by Bogdanovich to exist on the northern slope of the Kok-tan range (*Trudü*, etc. p. 72). Such basalts were found by us not only at the already-

Digitized by Google

mentioned places in the Toyun valley (see p. 105), but also in the farthest off-shoots of the mountains at Tagh-Tumshuk, not far from Maral-bashi.

Through a breach, a hundred feet wide, the Sugun river continues its easterly course and debouches to a spacious valley, about two miles broad, which in its turn again trending to the south-east, falls into the Kurumduk river. It should be noticed that the delineation of this region on all the maps known to me, especially the hydrographic system between the plateau of Tegermen and the Sugun district, and the continuation of this river system through the Kurumduk and right out into the Kaldy-Yailak plain, does not even remotely correspond with the actual facts. From Ayak-Sugun, which lies at the confluence of the already-mentioned lateral valley with the Kurumduk, we made our way to Sugun-Karaul. The route from the Kurumduk valley (which was itself traversed only for a short distance) to the plateau at the southern foot of the mountains, leads for over sixteen miles through narrow winding defiles across that section of the tertiary highlands, consisting of soft clays and marls, which have been subjected to the most profound shiftings of level. Owing to this fact it has been shattered, and, for the most part, buried beneath its own débris to an extent that has elsewhere been rarely observed. Before the marls lies a thick zone of very fine, hard conglomerates, which extend for two miles into the desolate, high Kaldy-Yailak plain.

I was now obliged, during the prevalence of the

Digitized by Google

severest winter weather, to undertake the long and difficult journey to Tashkent. Here I had to procure the instruments and photographic materials, long before ordered in Europe, to complete our equipment, and also to direct a second Alpine guide by telegraph from his home to Kashgar, where there is no telegraphic communication with Europe or even Turkestan and only a very defective and tedious postal service. I took the route over the Terek-davan (Irkishtam—23° C., Kok-su —28° C.). As this route has already been several times described, and most recently by Futterer (*Through Asia*), I may here pass over the observations that I made on my journey, though they present many points of interest.

During my absence Herr Keidel occupied himself with the investigation of the loess deposits in the Kashgar-daria valley, and also made an excursion to the southern border of the Kashgar basin. The way led through Boruk-tai to Tash-malik; a rich fossil fauna was discovered south-west of this place. From Tash-malik Herr Keidel went on to the Gess valley, which he followed up to Ak-chiu, where he made a collection of fossil plants of the Angara series in the coal-beds, worked in a primitive fashion by the Kirghiz. The return journey was made through Eski and Yangi-Hissar. A second excursion to Bash-Sugun, undertaken towards the end of February, had for its object the completion of the geological collection by a study of other levels in the local limestones. In the finds here made, various stages

Digitized by Google

of the carboniferous age are represented. Some specimens of the species of the Bash-Sugun fauna found their way to Calcutta, where they were recognised in the Geological Survey Office of India as corresponding with the Productus Limestones of the Punjab Salt-range.

Digitized by Google

CHAPTER IX

THE SOUTHERN MARGIN OF TIAN-SHAN BETWEEN KASHGAR AND UCH-TURFAN

At the beginning of March I was back in Kashgar from Tashkent, where, through the kindness of His Excellency the Governor-General, two valiant young Kossacks were placed at my disposal as escorts. At last, after much trouble, diverse bad incidents and unpleasant delays, the new Alpine guide, Sigmund Stockmayer of Neukirchen in Pinzgau (Salzburg), arrived with a portion of the instruments and materials that had been ordered. After completing all the other troublesome preparations, the hitherto very cold weather having also become a little milder, a start was at last made on April 14th, 1903, for a fresh expedition to the highlands. Beside myself and Herr Keidel, the party now consisted of the two guides, Kostner and Stockmayer, the preparator Herr Maurer, the two Kossacks Besporodoff and Simin, with the corresponding accompaniment of Sart attendants and horse-keepers. Later we were joined by Chernoff, another Kossack, who had been one of Sven Hedin's assistants. All the military posts along our route had previously received due information from the Chinese authorities in a way

Digitized by Google

that deserved my thanks. They also gave me written instructions and a policeman ("Beg") for a part of the way. Through the kindness of His Excellency N. F. Petrovsky, Imperial Russian Consul-General at Kashgar, to whom I am greatly indebted for much help, the Russian "Aksakals" in Uch-Turfan and Ak-su received notice of my approaching arrival. Though my residence in Kashgar had not been too pleasant, I still parted reluctantly from persons, whose kindly advances and disinterested support had stood me in good stead on many trying occasions.

As the raw weather and the masses of snow, lying on the uplands, did not yet allow us to push into the high valleys, I decided to journey at first for several weeks as closely as possible along the southern escarpments, in order to study their geological structure, as on this particular section of the Tian-Shan next to nothing was known. The route once more necessarily lead through Altyn-Artysh and Tangitar to Bash-Sugun. Still, the repeated visit to this locality was not thrown away, since it lead to the discovery of carboniferous Permian deposits.

My intention was to make my way over the Kara-bel passes into the Aiktyk valley, whose southern bank is formed by the "Kok-kya range," as it is called by Severzoff, why I do not know. Thence the descent could be made into the narrow ravines of the Kok-shaar river, cut between the aforesaid range and the section of the southern border-range also named by

Digitized by Google

Severzoff the "Bos-aidyr Chain." The project, however, was thwarted by the stupidity or the ill-will of the "Beg," appointed by the Chinese authorities to accompany me. I should here point out that the terms Kok-kya and Bos-aidyr, applied to mountain ranges, are unknown to the natives along the southern border.

From Bash-Sugun the way led east and north-east in narrow gorges through light-coloured, coral-bearing limestones, then along the southern border of the great mountain range across the surface of the plateau, where the outer range rises only in isolated crags above enormous, heaped up masses of mountain drift, like cliffs out of the sea. At the Kirghiz settlement of Kara-jil these crags of the front range reach a height of only fifty to sixty feet, and consist of interstratified light and dark limestones, the latter of which yielded a rich upper carboniferous fauna. The place must not be confused with the Chinese military post of like name, which lies farther north in the Aiktyk valley. Of this district, which was subsequently traversed by the expedition, the maps give an altogether inadequate representation, which will in many respects be corrected and completed by our route surveys.

From Kara-jil we travelled in an east-north-east direction along the foot of a limestone ridge, 1,600—2,000 ft. (500—600 m.) high, through the loess steppe, where the outer range, buried in the drift, may still be followed in island-like fragments for a long distance. Then we turned

Digitized by Google

a little south to the Kirghiz settlement of Jaiteve (tube?), on the shore of the saline lake Shor-kyl. At this point the expedition touched Sven Hedin's route of the year 1895, but again immediately diverged in a north-easterly direction, and made its way into a valley, which intersects the mountain range at an acute angle. This valley is of typical form, narrowing in its upper course to the shape of a ravine and becoming a perfectly developed transverse valley, sunk in hard strata of limestone, grauwacke and phyllite-like schists. We found this typical erosion-valley (Apatalkan) and its secondary valleys waterless, and only at the valley head came on a feeble stream, issuing from the snow-fields lying there. The origin of such a valley, and of other erosion-valleys, traversed by the expedition shortly before and afterwards in the journey to Uch-Turfan, cannot be explained satisfactorily by the periodical streams which flow through them only for a small part of the year, but much rather points to great climatic change.

The route led between mountains, whose steep sides, in consequence of the slope of the strata towards the north, were turned towards the valley, up to the Apatalkan pass, nearly 10,000 ft. (3,000 m.) in altitude; then down through the snow-clad northern Apatalkan valley (Uyuk-Apatalkan), of trough-like profile, where, notwithstanding the advanced time of the year (April 22nd), we re-entered in the region of winter and encountered violent snowstorms. The ramparts

Digitized by Google

of the valley consist of a regular folded mass, already much worn down, of phyllite-like schists and grey-blue grauwacke, both of very varying appearance. This horizon of great thickness can be followed a distance of twenty-five or thirty miles in the Kok-shaal valley. Kok-shaal is the name, given in general to the upper course of the Taushkan-daria by the population living on its bank. At the mouth of the Apatalkan valley, the Kok-shaal valley is already a mile or a mile and a half wide, and looking back one sees, only a little farther to the west, the river leaving the ravine, whence it issues through a door-shaped opening, and then rushing in a majestic curve into the distance.

To my regret time did not suffice for inspecting the ravine, from which this river issues, especially as it had never before been visited by any expedition. It is significant that in the Kok-shaal valley, as in all the less recent Tian-Shan valleys, we at once met with unusually large masses of conglomerates, which constantly accompany the course of the river, irregularly overlying the old schists, and in their turn overlaid by more recent conglomerates, etc.

At the locality of Abdul-kia, alias Alep-turga, about 8,200 ft. (2,500 m.) in altitude (these, like most of the following names, are not to be found on any of the existing maps)—the Kok-shaal river should be crossed, but, owing to the strength of the current, the passage proved impracticable. We had to travel along the limestone range on

Digitized by Google

the right bank, against the bluff walls of which the river beat for a long stretch, and hence induced us to take our way through defiles of the surprisingly eroded limestone ridges. Thus, travelling for some time near the border of the mountain mass, we again reached the main valley, where the river, now divided into several branches, could be crossed. Already at Ak-kia the view up the river had opened out to the fine chain of snow-clad, rocky mountains belonging, at least in a purely orographical sense, to the so-called Bos-aidyr chain (*vide* p. 113), for the separation of which from the continuous wall of the Kok-shaal-Tau, however, I can find no satisfactory boundary-line either from a geological or an orographical point of view. The route over the wide, slightly inclined steppe-terraces of the northern bank was now open to us. Passing the great Kirghiz settlement, Karabulak, with one of Yakub Beg's dilapidated forts, we crossed a plateau of consolidated pudding-stone (*Deckenschotter*), rising gently towards the north-east, and approached the foot of the rugged precipitous mountain rampart at the Aul of Chagash-gumbes, about 8,000 ft. (2,450 m.) in altitude. The secondary range of the Kok-shaal-Tau, which here attains a height of *circa* 11,500 ft., though it must, from a geotectonic point of view, be considered as separate from the higher ranges behind it, should, according to the maps, belong to Severzoff's "Bos-aidyr range." The native Kirghiz call it Markesh-tagh. The drift mounds

Digitized by Google

at its base contain no crystalline material, this front wall being composed of limestones, calcareous slates, and very dense, highly metamorphic, bright-coloured clay-slates and sandstones, which dip now to north-north-west, now in the reverse direction. Crystalline fragments (granite and syenite) which are brought down in the beds of several streams that break through the front range, appear to be derived from the higher ones behind; but lower down the valley I found in more recent drift, which there covers the base of the hills to a great depth, crystalline material (large granite blocks) in places, where no passage leads back through the lower range. They were doubtless carried hither by ice from the inner recesses of the mountain range. These are not the only traces of former glacial action which we found in the Kok-shaal valley; on the right as well as on the left bank such traces were proved to exist, though not very abundantly. The section of the Kok-shaal-Tau, to which the name of the Bos-aidyr chain is given consists of several nearly parallel chains, of which the hinder, more northerly, is much higher and possesses more variety of mountain shapes than the range in front. Its summits, clad with nevé, are very steep. Here there is displayed a characteristic of the configuration of the Tian-Shan, which I had already observed and afterwards often confirmed—that of its parallel structure. Semenoff, the most acute explorer who has ever visited any part of the Tian-Shan, long ago directed attention

Digitized by Google

to this law, which finds such abundant expression in the configuration of this giant range. The Kok-shaal-Tau shows, on the whole, a gradual ascent from west to east, as far as the neighbourhood of the Bedel pass, where a sinking takes place.

At the Kirghiz settlement of Kysyl-gumbes, about 7,500 ft. (2,300 m.) above the sea, which owes its name to the red colour of the loess surface, a result of the decomposition of the bright red ("kysyl" = red) limestones, conglomerates, and sandstones which form the steep, finely peaked ramparts of the valley, and to the many Kirghiz burial chambers ("gumbes") which distinguish the region.

An excursion to the so-called Bos-aidyr chain was arranged, and, for a better insight into its formation, one of its lofty peaks was to be climbed. But, to my regret, this purposed excursion came to nothing, owing to a phenomenon, which, regularly, during the long time the expedition was engaged on the south side of the range, made observations exceedingly difficult and partly impossible—namely, continuous and unusually dense fog. The fog was, in this early part of the year, almost denser—at all events it was much more continuous—than we find it in the Alps in November (a surprising phenomenon in this southern region, distinguished by the dryness of its climate); for weeks at a stretch there was no clear weather. The explanation lies in the intense heating of the loess soil during spring-time. This, at some hours of the day, whirls

Digitized by Google

the fine dust aloft, and, even when the wind is calm (to say nothing of the strong winds which often prevail), drives it in commotion up to the higher strata of the air, where it remains floating. In spring, in consequence of the melting of the snow, the mountain slopes give off much moisture by evaporation, and these vapours are condensed on the fine floating dust-particles to mists which neither fall nor yield. In April and May we had often a cloudless sky, but seldom a clear atmosphere. Our photographic work had to be discontinued often for many days—a serious loss. Over much that was worth observing on our route, lay an impenetrable veil.

In the limestones which are mainly concerned in the formation of this front range, we found beds containing corals, whose identification will perhaps help to determine the age of these strata, which, also on the right bank of the Kok-shaal, form ranges of imposing height.

At the place called Ak-tala we crossed again to the right bank. Here, and even earlier, the mountain range along the bank, the Sogdan-Tau, showed remarkable development in the impressive perspective of a lofty rampart with a crest-line of about fourteen miles (twenty versts) length, almost without a gap, deeply covered with snow, and on the average about 4,000 ft. (1,200 m.) above the floor of the valley. Behind it a far higher range (again a parallel structure), with a somewhat greater variety of form, and bearing small glaciers, became visible.

Digitized by Google

The existence of glaciers is indicated also by the name of a transverse valley, Uch-Musduk, which means "Five Glaciers." To this Sven Hedin has already directed attention. This great mountain range, occupying a wide area, is still altogether *terra incognita.* Our route along its border led us into a longitudinal valley of considerable breadth, where there are strata of laminated, green phyllitic schists, interchanging with strata of grey sandstone in a regular, rather sharply folded formation, whose partially eroded arches may be followed for a great distance. These strata, as was afterwards proved, at different points, overlie discordant limestones, which strike obliquely across from the left bank.

Also, in this now waterless region there are wonderfully perfect erosion-valleys. Near the Aul of Sum-tash, in the neighbourhood of which are the still unknown ruins of an ancient town, complicated foldings in the same rock-series are disclosed, and the limestones, seen below, crop up to the surface at the Kok-belys pass, which we crossed, where they contain a bank bearing brachiopods, and lie discordant among argillaceous schists. The structure of the mountain chain onwards steadily engages the attention in consequence of the magnificent disclosures of its interesting stratification, but this subject cannot be discussed in this summary report. Herr Keidel will make good this and other deficiencies in his detailed geological description of the regions traversed.

Digitized by Google

As we descended an affluent to the main valley we reached the Kirghiz settlement of Uch (on Hassenstein's map wrongly placed on the left bank) about 6,400 ft. (1,950 m.) in altitude, and subsequently we again struck Sven Hedin's route of 1895. Among the magnificent, gorge-cleft mountain ramparts at Uch, where, from a height I climbed, the three parallel chains of the Sogdan-Tau were visible, a collection could be made of the fine rich fauna of the upper carboniferous formation, here existing in two distinct horizons, lying in slight discordance. This rock sequence can be followed far to the east. Here for the first time we discovered foraminiferous schists (bearing *Schwagerinas*), which from this point steadily accompanied our route along the southern slopes as far as the Khalyk-Tau. The extraordinarily wide area, on which these foraminifera, which characterise the uppermost carboniferous formation, are distributed, is a new fact in the stratification of Central Asia.

In the continuation of our journey eastwards we constantly found magnificent disclosures of the same compactly folded system, running north-east and south-west, especially fine in the Aul of Shinne. Immediately thereafter, toward the Karaturuk gorge (this on Hassenstein's map is marked to the east instead of to the west of the pass), the river dashes impetuously against a cape-like projecting spur of the mountain range, and makes it necessary to cross the rocky pass of Shinnedavan, in the neighbourhood of which, owing to

Digitized by Google

the oblique cutting through the folds, highly interesting geological disclosures can be seen. Again there appears the rock-series of the horizon of Uch, discordant under schists, and, farther on, old stratified conglomerates overlaid with black limestones and reddish clay-schists, a series which accompanies our route over the next pass and onwards through a valley into the plain, where, in the neighbourhood of the Aul of Sary-turuk, it is replaced by hard, dull-coloured, crystalline limestones, which now, in a series of banks of immense thickness, form the mountain wall over Ak-kia to the richly cultivated Aul of Safar-bai, about 6,000 ft. (1,850 m.) above the level of the sea. The much higher, snow-clad mountain range, which accompanies the river on the left, remained, during this long journey through the Kok-shaal valley, which is often as much as two and a half miles (four versts) in breadth, in consequence of the thick fog (*vide* p. 118 *seq.*), almost continually invisible. The river-bed is several times constricted to a breadth of 600 to 900 ft. (200—300 m.) by cape-like projections, where the ridges, set obliquely to the axis of the main valley, have been much eroded by the action of water and wind, but the average breadth of the valley is not diminished.

At the Kirghiz settlements of Kara-bulung on the right bank and Bulung-turuk on the left bank the river makes a great bend, and bears henceforth the name of Taushkan-daria, or is even called simply Daria. There, from the wall on the right shore, which at the bend swings far to the south-

Digitized by Google

west, low ridges of fossil-bearing limestones run forward to the river. Beyond the Aul of Koshe-bashe, where the loess-plain on the right bank showed rich cultivation, the river presses suddenly against this bank and reduces it to a mere strip. Even this vanished at last, and then our route, since it was found impracticable to cross to the low left bank, led over a projecting cliff of marble-like limestone to the pass of Denge-davan. In the ascent I found the cliffs, up to approximate heights of sixty-five feet (twenty metres) worn by water—one sure sign of many I observed in the main valley, either that the river has deepened its bed, or that it formerly had a larger flow of water, or that both of these suppositions are true. On the eastern side of these cliffs the rock-walls are, owing to æolian corrosion, pierced high up with thousands of little holes, a phenomenon which may be observed at many places in the Kok-shaal valley on the windward side of the cliffs, but nowhere else so finely as here. In the neighbourhood of the Aul of Konganishuk-Yangyll, again, a low ridge juts forward from the chain bounding the main valley on the right to the river-bed, or, indeed, into it; this is through erosion, partly by water and partly by wind, divided into separate small rocky islands, two of which rise in the middle of the bed of the river. This row of cliffs, which the Kirghiz call Mai-tewe (tube?), consists of coarse, dark-coloured limestone conglomerate, interstratified with sandstones; the limestone fragments contain a rich fauna, belonging to the upper carboniferous

Digitized by Google

formation, of which we collected specimens. To judge from the flat depression of the strata and from the arrangement of the folds, this horizon might be followed far to the east and south-east; it was, in fact, again met with farther to the east.

At Bash-chakma, about 5,600 ft. (1,700 m.) in altitude and at Tagh-tumshuk, the commanding mountain range on the right bank is developed on a great scale (here also three parallel chains could be observed), and by its height and arrangement it forms a remarkable shelter for the region, which now at length (at the end of April) showed the first green of spring and the charming hues of blossoming peach- and apricot-trees. There, on a sharply projecting mountain spur, could be observed complicated disturbances, several flexures, faults, and ruptures, which could be followed away to the east and north-east in a complex stratum of slabby limestones, quite void of fossils, loose sandstones, and red-brown quartzites. Farther on, at the Aul of Kum-bulung, however, only these sandstones appear; they form great arches in thick layers, and the products of their decomposition have transformed the region far and wide into a desolate sand-desert, from which a bit of soil for cultivation can only with difficulty be wrung. The protruding dark-coloured limestone ridge of Ot-bashi-tagh sets the first limit to the driving of the sand, at a bend of the river. Under its shelter the diligence and skill of the population (from here onwards exclusively Sartian) have turned the region into an incom-

Digitized by Google

parably luxuriant garden-land, which extends to the town of Uch-Turfan, about 5,000 ft. (1,500 m.) in altitude, and beyond it. These dark-coloured limestones accompany the route in crowded folds, frequently with remarkable bendings of the strata; in them also there is an upper carboniferous fauna, of which Herr Keidel collected fine specimens. A projecting spur, formed of these limestones, bears on its summit the picturesque citadel, commanding not only the town and its handsome walls, built on the Vauban system, but also the garden-like region far and wide. This cliff consists partly of great banks composed exclusively of *Productus* and *Spirifer*, from $\frac{4}{5}$ to $4\frac{3}{5}$ in. (2—12 cm.) in diameter.

Digitized by Google

CHAPTER X

TO THE KHALYK-TAU AND BACK TO UCH-TURFAN

In accordance with information obtained, I had to put off my purpose of penetrating from Uch-Turfan at this time into the transverse valleys of the left mountain range, since in those valleys there was at the time snow, of course, but no fodder for the horses, and the helpful Kirghiz had not yet come up. I therefore resolved to go farther east into the Khalyk-Tau, which had never before been visited by any explorer, and whose transverse valleys, opening directly to the south, might be expected to offer more favourable conditions. Our way would lie across Ak-jar, Shah-shambe, and Tjaggerak to the town of Ak-su. Along this route we could at length (in the first week of May) begin gathering the first spring flora of the steppe.

At Ak-su we had to stay for several days to complete our number of attendants and of horses as well as to meet the Chinese authorities. We left the interesting town on May 7th by the old caravan road to Bai, and crossed, between Kara-Yulgun and Tugarakdan (according to the incorrect representation of the forty-verst map, it would lie between Jurga and Yakka-aryk), the tertiary

Digitized by Google

mountain range of the Chul-Tau which trends west-north-west, the route lying in an oblique cutting through its fine system of arched folds. Bright-coloured banks of sandstone and clay marls, bearing gypsum, overlaid by slabs of conglomerate, compose the mountain range, whose structure is far less complicated and whose appearance therefore has less variety of form than the Topa-davan range in the north-west (*vide* p. 99 *seq*). The crest elevation of the central portion is of course higher than there, but in its eastern chains between Jurga and Yakka-aryk and farther east it is much weathered and already reduced to insignificant dune-shaped swellings; by its decomposition it has furnished the material for a considerable rise in the level of the plain eastwards. This plain reaches its highest point at Chakh-chi, about 4,760 ft. (1,450 m.) in altitude, and from this spot it falls away towards the Musart-daria.

The visit to the town of Bai was of doubtful value. The information there obtained with great difficulty from the Chinese authorities concerning routes and conditions in the Khalyk-Tau turned out to be incorrect. It appears that nobody there is well acquainted with that almost inaccessible mountain region. The forty-verst map here leaves us completely in the lurch; between Bai and the mountain range it presents nothing but a blank, and what of Khalyk-Tau is elsewhere shown proved wrong. As the topographical sketches, taken during the journey are not yet worked out, our course, in the absence

Digitized by Google

of a topographical basis, could only be made clear by very detailed explanation; I must therefore reserve a minute description of this portion of our journey and, in this provisional report, only state the most essential points. But it must be mentioned that the direction and course of the rivers, given in the forty-verst map do not agree with facts: The Kapsalyan river, the most important of the rivers of this range, on issuing from its narrow, ravine-like valley, takes a direction towards the south-west and west along the southern slope of the range, and the river which issues from the valley, wrongly named Kasnak-su on the forty-verst map, but in fact bearing the name of Terek, does not flow into the Musart-daria but into the Kapsalyan, which for its part only reaches that stream in the neighbourhood of Chakh-chi. Finally, Bai is at a much greater distance from the foot of the mountain range, than it appears to be on the forty-verst map.

Our route passed from Bai in a north-westerly direction over Terte and Uskim through the desert to the small kishlak of Masar-Yakub, which is still at a considerable distance from the edge of the mountain range. Here it turned out that our next destination, the Tilbichek side-valley, cannot be reached directly, since its lower course forms a ravine, inaccessible for beasts of burden. We had to bear westwards and traverse the desert-valley of Kali-agach, which is cut into recent crystalline conglomerate. We crossed a small pass and, going along a hollow, running

Digitized by Google

south-west, reached an elevated plain, and then went to the village of Jam-kuluk, about 5,500 ft. (1,600 m.) in altitude, situated on the plain at the foot of the first chain of older conglomerates, near the mouth of the Kapsalyan river. The route upwards in this valley had an easterly and north-easterly direction; the valley is sunk between rugged, high, red conglomerate ramparts (of which more hereafter), and is divided into three small basins (old lake-bottoms), connected with one another by door-like openings, cut in the enclosing rock-walls. Thus we reached the region of tertiary, bright-coloured clay marls, which are steeply folded together with the hard, violet-red conglomerates, but, already very much destroyed, are for the most part now only found at the foot of the steep conglomerate walls, 650 to 1,000 ft. (200—300 m.) high. Over these marl terraces, at one side of which the river flows in a deep gorge, we travelled up the valley to the Taranchi settlement, called Musulyk, about 6,000 ft. (1,820 m.) in altitude, lying on a raised sill, deeply pierced by the river. Thence we went to the junction of the Terek with the Kapsalyan, and approached over a boulder-plain the spot, where the latter issues from between the steep walls of the lofty limestone range. We then left the basin of the river, and crossed the broad water-shed between it and the Tilbichek river-basin through a defile about seven miles (ten versts) long, which, following the strike of much decomposed, variegated banks of marl, displays wonderfully varied and bright-coloured

Digitized by Google

strata, especially where the red conglomerate walls, with their boldly peaked crest-line, overtop these steep, jagged marls. Over a steep slope we descended into the wide plain of the Tilbichek valley, whose door-like entrance into the gorge of its lower course was at once visible behind us to the right. In the middle portion of the Tilbichek valley, the soft marls are almost cleared away, and the conglomerates alone form, by their strike, the ramparts of the valley. Since they dip steeply towards the south-east, the orographic right wall is sloped steeply enough, but the left wall presents towards the valley perfectly perpendicular precipices, forming a wall twenty versts long, sheer by the plumb-line, red, crowned with odd peaks and pinnacles, a sight such as is seldom seen elsewhere. A small Taranchi settlement in the valley is called Sukhun, about 6,400 ft. (1,950 m.) above the sea. Thence we penetrated deeper into the valley, first going north-eastwards, then north, where the still-preserved parallel folds of the steep, variegated marls, rising in serrated crests behind one another, together with the conglomerate walls, group themselves into the most peculiar shapes. In this geological horizon lie three basin-shaped widenings, which are connected with one another only by door-shaped openings, thirty to forty feet (ten to twelve metres) wide. Through the last opening access is gained to a region of light grey, fine, sandy conglomerates, which pass into actual sandstone and enclose clay-coal schists (*Lettenkohlenschiefer*)

Digitized by Google

with impressions of plants, and higher up there are dark-brown, poor clay-ironstones and grey, dense limestones. Far behind in the valley a Taranchi, living in a cave, is occupied in smelting iron. The main valley here branches and leads towards the north-west, over lofty terraces, clothed with Alpine meadows, to a pass; the main branch, however, leads northwards as a narrow gorge, with almost perpendicular walls of dense limestone, between which flows a raging torrent. To Herr Keidel's attempts to penetrate deeper into the ravine, and so from the limestone belt to reach the crystalline, insuperable obstacles at once presented themselves.

The second excursion into the mountain range was farther west, through a narrow, door-like and difficult breach in the red conglomerate walls to the Kepek-chai valley, where the region of the bright, grey, sandy conglomerate, sandstone, clay-coal schists, and clay-ironstones, already mentioned, is reached much sooner than in the Tilbichek valley, since this system of strata runs about north-east and south-west. In the background of the valley the most complicated forms of stratification, inclined folds, contortions, over-slidings (*Überschiebungen*), etc., accompanied by chaotic destruction of the rock-series, can be observed at magnificent exposures. These disturbances, after more minute examination of the observed conditions, may probably prove to be associated with the already-mentioned disturbances in the southern Musart valley (*vide*

Digitized by Google

p. 93 *seq.*) since the crystalline rocks strike across from that region and go somewhat deeper into the mountain range in contact with the sedimentary rocks. The red conglomerates and tertiary marls, being much more recent, were not involved in this movement.

We ascended the Busai-tash pass, about 9,200 ft. (2,000 m.) in altitude, leading into the Tilbichek valley, and thence over extensive Alpine plateaus, about 800—1,000 ft. (250—300 m.) higher, which spread out between the two valleys, named and the Kapsalyan valley. These plateaux provide a fine view of the snowy chain of the Central Khalyk-Tau. The highest peaks lie to the north and west; towards the south and east there is a gradual falling away. Turning back towards Musulyk, Herr Keidel attempted to penetrate into the Kapsalyan valley, but was baffled, the narrow gorge being completely filled with water. Only in winter, if the river is low or is frozen, the Taranchi penetrate into the valley and carry away fir-wood. Herr Keidel, in order to obtain an insight into the structure of the range, now resolved on the ascent of a high peak, about 12,000 ft. (3,600 m.) in altitude, standing between the Terek and the Kapsalyan valleys, while I penetrated into the Terek valley, which likewise has the character of a much-winding ravine, but, nevertheless, proved passable. From a bivouac about 8,000 ft. (2,450 m.) in altitude, midway up the gorge, I was fortunate enough to reach its head, about 9,700 ft. (2,950 m.), where it divided

Digitized by Google

into two clefts, running up to the main water-parting ridge. I could thus traverse the whole series of the sedimentary rocks lying on the outer border, the crystalline belt, forming the middle course of the valley, and the limestones and old argillaceous schists forming the valley-head. Thus I was able to collect a complete sequence of the rocks. Just as in all other transverse valleys of the Central Tian-Shan, so also in the Khalyk-Tau, it is not the crystalline rocks, but the limestones and argillaceous schists, which form the highest and most central portion of the range. Here these limestones and schists on the whole strike east and west, with slight deflections towards the south and north. These conditions, however, according to observations already made on the Musart pass, could not be expected otherwise. In the crystalline rock of the Terek valley, remarkable disturbances, inclined folds, violent compressions and overslidings, etc., were noted. Even far up the valley, but especially at the entrance into the Terek gorge, at the little settlement of Bom-khotan, there exist *Schwagerina*-bearing limestones, which interchange with plant-bearing schists; a little farther down the valley, after red sandstone there follows a belt of porphyry between the former and the frequently mentioned grey sandstones and conglomerates.

It surprised me to find in this southern valley, opening to the south, the features of a narrow transverse valley of the northern limestone Alps: terraces with Alpine meadows, and on steep, rocky slopes forests of pine, which extend into the

Digitized by Google

recesess of the ravine and, on the valley-terraces (*Thalstufen*), form dense permanent forests ; a main stream, well supplied with water by many brooks, flowing from genuine Alpine side-valleys ; splendid snow-clad, rocky peaks. At the head of the valley, where, as before mentioned, it divides into two narrow clefts, no glaciers can be formed, but there are small glaciers at the heads of the side-valleys, which widen out into the form of cirques. At the mouths of some of these valleys, though much has been washed away by floods of the stream, there are still considerable quantities of moraine débris, piled as evidence of former extensive glaciation. The whole length of the Terek valley amounts to about thirty-five miles (fifty versts) ; at a short distance from its head it divides into two branches : the one, running north-westwards, is called Ya-konash ; the other, running mainly northwards, is called Jan-kasnak. From this latter name the appellation of Kasnak-su, which is given in the forty-verst map to the whole valley, is perhaps derived. I repeat that the inhabitants of the region denote the whole valley simply by the name Terek. Our return-route from the Khalyk-Tau lay close to the skirt of the mountain range : first upwards, in the lower course of the Terek valley ; then across the lofty terrace of Yarjilga, which apparently closes the valley, down to the wide plain of Karabag, which extends between the longitudinal course of the Musart-daria and the foot of the range. The transverse valleys at this part of the Khalyk-Tau are not inserted,

Digitized by Google

IN THE UPPER TEREK VALLEY (KHALYK-TAU).

[*To face p.* 134.

Digitized by Google

Digitized by Google

much less named, in any map. In the order from east to west their names are: Yagus-tal, Kysyl-tal, Tutuk-tery, Cholok-su, Alagyr, Tyukur-myt. I found all of them, notwithstanding their southerly exposure, very snowy, and in some there were considerable glaciers. They are terminated by a mountain ridge, running north-west and south-east, which crosses obliquely from the Musart valley, and for this reason the most easterly are short, while, in general, their length increases the farther they lie to the west. The most important of them is the Tutuk-tery valley, from which a great mountain-river flows. Most of these valleys contain pine forests, in which the inhabitants of the widely scattered kishlaks of the high plain burn charcoal.

Our route lay across the kishlaks: Kish-talga, Karabag, Kok-kya, Little Karabag, Kyssalik, and Chapta-khanne—continually along the edge of the mountain range, which falls away towards the high plain in walls about 4,000 ft. (1,200 m.) high. Along the foot, however, there is a belt of tertiary deposits, more or less destroyed and carried away. After crossing the Musart-daria, which here, at Chapta-khanne, presses quite up to the mountain wall, the road leads without intermission over old moraine-soil, over-grown with verdure, across a number of moraine-ridges, running north and south, cut by little cross-valleys; on these ridges lie massive erratic blocks (*vide* p. 97). From this enormous accumulation of moraine débris the route descended steeply to the first Chinese picket,

Digitized by Google

Koneshar, at the entrance of the southern Musart valley, where we made our appearance on May 23rd. On the assurance that, in accordance with the orders of the Chinese authorities at Ak-su, which had been forwarded to the Sartian "Begs," I should find fodder for the horses and provisions for the company ready at all stations, I resolved to pay another visit to the southern Musart valley. My principal aim was to penetrate from the last picket, Tamga-tash, to the unexplored Karakol valley, which extends thence to the north-east, and become acquainted with the very important glacier of this valley, probably one of the largest in the Tian-Shan, and also to explore its surroundings, which consist of completely ice-covered mountain chains of gigantic height, whose connection with the great main ranges still remains obscure. The extensive glacier background of the Turpal-che valley was also to be investigated. To my deep regret these plans could not be carried out, since the "Begs," notwithstanding the orders sent them, left me in the lurch.

I first made, from Tamga-tash, a tour of inspection to the great Karakol glacier, whereby it was established that this glacier, like the Inylchek glacier, is overspread with a great coating of moraine débris, the passage of which, to a length of only for two and a half miles (four versts), took much time and proved very troublesome. So far as could be seen from an elevated crest on the left bank of the valley, this débris mound extends still farther over a stretch of about seven miles (ten versts) up

Digitized by Google

the glacier before free ice can be reached. This has certainly three times the length of the moraine-covered part. At the end of the glacier tongue there is a small moraine-lake. The traversing of the glacier and the investigation of its environs would have required at least a week. When I had returned from this trip to the picket, it turned out that only an insignificant quantity of fodder had been brought, and there was no more in prospect. I had therefore to hasten my retreat from the inhospitable valley, and, to my regret, to give up the investigation of this region, the most unexplored of the Central Tian-Shan. Though this trip had cost me a week's time, it had not been taken in vain, inasmuch as the geological, glacial-geological, and orographical conditions of the Musart valley, already briefly described, had this time been more fully investigated, than was possible in the flying visit of the year before. Unusually violent winds, sand-storms, and mist to some extent interfered with the work.

By the route, already indicated, we returned to Ak-su, where now the Kossack Chernoff, one of Sven Hedin's attendants, joined the expedition, and at last, after incredible difficulties, the long-expected supplies and outfit, absolutely indispensable for the continuance of our work on the high mountain range, were completed.

Uch-Turfan is more favourably situated as a point of departure for the investigation of the southern transverse valleys, since it is nearer the mountain range, and we therefore returned to that

Digitized by Google

place. On the way a rich collection was made of the steppe and desert flora, now in the freshest full bloom. Being properly supported by the Chinese "Ambal" at Uch-Turfan, a well-informed and agreeable man, as well as by the Sartian "Aksakal" of the Russian Consulate in Kashgar, I could satisfactorily carry out my investigations in the hitherto quite unexplored side-valleys of the south Central Tian-Shan.

The atmosphere had in the meantime become transparent, and from Uch-Turfan we had daily a clear view of the southern mountain range. The great abundance of snow, and especially the rich glaciation of these southern chains, far exceeded my conceptions. The background of the Kaiche valley, with the wonderfully bold mountain peak marked by Kaulbars with the name of Petroff peak (not Peter peak), the magnificent Bos-tagh group, and, more than all, the mighty, completely glaciated Sabavchy chain, formed a series of surprises, considering the exposure of the slopes facing to the south, or partly to the west.

Digitized by Google

CHAPTER XI

THE SOUTHERN TRANSVERSE VALLEYS—THE ALLEGED AND THE ACTUAL BREACH, FORCED BY THE NORTHERN WATERS.

We left Uch-Turfan on June 11th, crossed without difficulty the Taushkan-daria, which, however, had become much swollen, and, gradually ascending the deeply intersected débris-coating of the desert, approached the foot of the mountain range.

What we had already learned in our journey along the southern base of the Tian-Shan was here for the first time shown in the most convincing manner: of the so-called wall-like descent of the Tian-Shan towards the Tarim basin, of which so much has been written and which one would expect from the representations of maps, there was, except at a few places, nothing to be seen. The veil of haze surrounding the mountain range and the sharp light of the steppe produced this false impression on travellers, who passed along at a greater distance from the mountains. Nearly everywhere the Tian-Shan slopes away gradually towards the high plain at its southern base, in places (according to peculiarities of structure of its different parts and the corresponding course of erosion), sub-

Digitized by Google

siding gradually in ranges of transverse spurs, whose cape-like ends project far into the desert, or in other places in the step-like tailing off of longitudinal ranges. Besides, if it is considered how much of the outermost skirting range lies buried in the enormous rubbish-heaps of the high plain, frequently mentioned in this report, the hitherto prevailing conception of the wall-like descent of the range must be given up. In some places limestones appear as projections from the range; at others, conglomerates and tertiary clay marls form the outermost folds.

Our first stopping place was the oasis of Kukurtuk, on the little stream called Ui-Bulak, distant about sixteen miles (twenty-five versts) from the outlet of the Kaiche valley, and about 5,300 ft. (1,620 m.) in altitude. With the help of the Kirghiz of that place we penetrated into the Janart valley, to determine what connection it has with the alleged Janart-breach through the mountain range, and how far the representations, hitherto given on maps would be confirmed. On the high plain, on approaching the Janart river, I found indeed a river-bed about 130 ft. (40 m.) deep, cut into the boulder deposits, and wide enough even for great floods, but not such as would indicate a powerful river. The quantity of water, flowing through it, was clearly only moderate. These circumstances alone sufficed to make me doubt the existence of the so-called Janart-breach. At the entrance into the mountain valley, 7,400 ft. (2,250 m.) in altitude, where

Digitized by Google

the inevitable *Schwagerina*-bearing limestones—much compressed, however—again appeared, I was surprised to find a shallow, trough-shaped river section and a rather strong mountain stream, but no mighty river, such as must be formed by the united waters from the largest glaciers on the north side: the Sary-jass, Inylchek, Kayndy, etc. The flood-marks on the rock walls showed a height of ten to thirteen feet (three to four metres) over the then level of the river. With the determination of this point my conviction was sealed, that not a drop of water flows through the Janart valley from the northern glaciers. However, I wished to exhaust the evidence of this, and resolved to traverse to its head the valley, which has a length of about thirty miles (forty-five versts). We only rendered this undertaking feasible by moving our camp forward three times.

In the first third of the valley, light-coloured, dense limestones form the boundaries, and the character of the southern steppe is displayed in the midst of a magnificent rocky circumvallation. In the second third, where the valley assumes a north-Alpine character, with good meadow-spaces and fine pine-woods, it is bounded by crystalline schists and granite rocks, followed by a second series, consisting of light-coloured limestones—interstratified with dark limestone schists, and a ponderous series of dark schists and light marbles succeeds this. A thin belt of green grauwacke-schists and phyllites appears to be the outcrop of the similar rock-series, observed in the upper

Digitized by Google

Kok-shaal valley, but there in a much thicker horizon (*vide* p. 115 *seq.*). Then again follow limestone schists and marbles, reaching almost to the head of the valley. The last third shows a gorge-like form, but quite at the end is a fan-shaped widening, where the glaciers spread out. In the highest region we found in the circumvallation of the pass a belt of granite which, at least in its southern slope, has but little breadth. The whole of the complex stratification is very steeply set; the mean direction is E. 10° N. In interstratified limestones and limestone schists Herr Keidel found a carboniferous fauna, which seems to belong to two distinct horizons. The glacier in the main valley has no great extent; in the side-valleys, especially in those on the west, the glaciers are somewhat more extended, but are rapidly retreating. So much the more surprising are the great accumulations of moraine débris, which even at the outlet of the valley, rise high up against the rocky walls. In the middle of the valley, where the steep form of the rock-walls did not admit of their preservation, the river has cut its bed deep, and we saw the remains of ancient ground-moraine under the alluvium. Behind, the valley is for a long stretch choked up with great moraine-masses, so that, to reach its head, one has continually to cross great walls of blocks and boulders; among these only a very little crystalline material is to be observed. At the ice-clad pass, 14,500 ft. (4,400 m.) in altitude, we stood in the midst of a magnificent

Digitized by Google

PEAK (ABOUT 20,500 FT.) EAST OF JANART PASS.

[*To face p.* 142.

Digitized by Google

UNIV. OF
CALIFORNIA

Digitized by Google

environment of exceedingly rugged, ice-clad, rocky peaks, whose summits probably considerably exceed 16,000 ft. (5,000 m.) in altitude. On the north side our gaze fell on a wide, rock-bounded basin of nevé, which drains through a narrow winding gorge, no doubt, to the Ishtyk-su. An ice-clad chain with no variety of form hinders a more extended view on the north-west; judging from our position, it can only be Ishigart-Tau. Lofty peaks near at hand obstructed the view of the Central Tian-Shan. To the west it might perhaps have been possible, through an opening in the ice-clad ramparts, to get a sight of the glacier of the Kaiche valley, which would have been of interest to me for the sake of settling the position of the commanding Petroff peak, which I had already seen from various points (*vide* p. 138); but time for this purpose failed.

It was now established that the Janart valley does not cut through the range, and that by its channel no water can flow from the north to the south side. Still, the problem was only half solved; the question as to what route these waters really take in their southern course was still open. The large secondary valley, the Munkys valley, which runs parallel with the Janart valley in its course through the mountain range, and does not unite with it till it reaches the plain, might possibly be the channel by which the waters flow from the north side, and to convince myself whether this was so, I visited this valley. There I found a very wide and very deep river-bed, but with

Digitized by Google

little water; moreover, after having penetrated five miles (eight versts) into the valley, I could already determine with certainty that at the valley-head there could be no breach through. The Kirghiz were well acquainted with the fact, that the waters flow from the north side to the south side, and they consistently indicated the Kum-aryk as the channel by which they are conveyed to the Taushkan-daria. To convince myself of this was my next task. The most advisable route to the Kum-aryk would be that near the foot of the mountain range; for by that route it could be observed whether any other important river flowed from the range.

In all existing maps the transverse valleys, which cut the southern slope of the range between Bedel and Kum-aryk, are inserted very incompletely—most fully as yet in the map given in Krasnoff's Report (*Sapiski, I. R. G. G.* tom. xix. 1888), but even in this a number are wanting. I may therefore set down their names here, in the order from west to east: Bedel, Kok-rum, Tanke-sai, Myn-dagyl-bulak, Kukurtuk, Aire, Kaiche, Taltan-su, Janart, Munkys, Sindan, Kosh-karata, Ui-bulak, Ulu-jailak, Ulak-teke, Kum-aryk. Of all these the Bedel, the Kok-rum, and the Janart carry the most water. The water of most of the others soaks into the rubbish which forms their bed, and only comes to the surface again at various places far to the south. From the Janart eastwards the Sindan, which moreover enters the Janart on the plain, is the only river, which has

Digitized by Google

EASTERN MARGIN OF JANART PASS.

[*To face p.* 144.

Digitized by Google

Digitized by Google

continuously a considerable flow. Its bed is cut into unusually large banks of débris-deposits. The other river-beds carry only at times, but then in considerable quantities, the water from the melting snow to the Taushkan-daria. The route eastwards took the expedition through a wide extent of the tertiary mountain range, which, north of Uch-Turfan, strikes south-west and north-east. It consists of conglomerates, lying in a wide, flat anticlinal arrangement. The abundance of water there is astonishing; it cannot have been produced in this hot, snowless region, but evidently flows underground from the high mountain range, and only comes to the surface here. Some of the springs are salt. In the middle of the boulder-strewn desert lies, at the foot of this chain, the important oasis of Kuchi, a Taranchi settlement about 5,300 ft. (1,600 m.) in altitude. It proved exceedingly difficult to get trustworthy information there, concerning the route to the Kum-aryk. Mistrust and fear inspire these people. Only this much could be ascertained, that the continuation of our route directly eastwards was impracticable, since the Kum-aryk in that direction forms a single, impassable stream. It was necessary to go south-eastwards to the oasis of Oi-tattir, where the river is divided and can be crossed in the morning hours. We travelled through a desolate desert, only adorned with the splendid Sabavchy chain, which, towering in the north-east, stretches, a dazzling white wall, far to the east. This route crosses a wide stretch of country,

Digitized by Google

sprinkled with ruined, abandoned farm-buildings. Not long ago, water could be conducted to this region from the Kum-aryk, and the country was flourishing. It seems that, meanwhile, the river has deepened its bed; the canals can no longer receive water, and the region has reverted to a desert. Oi-tattir, about 4,900 ft. (1,480 m.) in altitude, is a very fertile oasis, which takes from the Kum-aryk more water than it uses for its crops, and the soil has become marshy. Two miles (three versts) eastwards from this oasis we crossed the stream. It spreads out its water to a distance of nearly three miles (four versts) in fourteen considerable and several small arms, with an aggregate breadth of 560 ft. (170 m.) and a maximum depth of 4 ft. (120 cm.) at the hour when the water is lowest. In the afternoon, towards evening, the quantity of water is more than double that of the morning flow, and the river is then impassable.

Already Sven Hedin, who in 1895 crossed the river at Ak-su, where it is called the Ak-su-daria, had showed that its water-supply on June 8th was 306 cm. per second (at what time of day?), or almost as large again, as that of the Taushkan-daria. The name Kum-aryk is not in the forty-verst map, but is that commonly and exclusively used by the inhabitants of its banks. It is, moreover, very suitable, its meaning being the canal (or channel) of the desert. On issuing from the gorge, in which it traverses the mountain range, on to the high plain, it flows in a cleft, about

Digitized by Google

500—650 ft. (150—200 m.) deep, cut perpendicularly in the drift-bed, so that the region along its banks remains waterless, a perfect desert which, interrupted only by a few oases, stretches to Ak-su. Between the arms where we crossed it, are stretches of desert with moving sand and sand-dunes. In the tract over which we travelled after crossing to the east bank, a continuous, narrow belt of fertile oases extended for several versts along the sides of a great canal and at the foot of a high embankment-like stage, with which the high plateau, which rises steeply to the mountain range, falls away to the level of the river. This row of farms, ten to twelve miles (fifteen to eighteen versts) long, hidden under fruit-trees, is divided into four Auls: Chandar, Tokai, Togak, and Shaikhle; in addition to the waters from the canal they receive also some water from two streams, issuing from the mountains farther east, the Chorlok and the Tamlok. The last-named oasis, Shaikhle, formed our base for the excursions following.

As soon as I saw the Kum-aryk, a river with, especially in the afternoon, an imposing volume of water, it became clear to me that such a flow could owe but little to the snows of the south side, and that this must be the river which is fed by the waters from the great glaciers of the north side.

We travelled from Shaikhle under the slope of the high terrace first westwards to the bank of the river, there flowing in a single channel about 400 ft.

Digitized by Google

(120 m.) wide, but soon turned from the river northwards through a gorge, cut deep in the thick accumulated rubbish, and, gradually ascending, reached the barren boulder-floor of the plateau. There on the lofty bank, always 650 ft. or so above the river, now flowing from the north, we pushed on up the valley. After some time the plateau became divided in a complicated manner by deep ravines, cut perpendicularly, mostly over 300 ft. (100 m.) deep. We descended to the river-bed and held on our way at the side of the water till the stream, beating hard against the wall of the gorge, forced us back to the plateau. With continual ups and downs in crossing the ravines we toiled on our way, till at length, after we had followed the course of the valley for about seventeen miles (twenty-five versts) our further advance was stopped opposite the place, where the Kum-aryk breaks forth from its narrow gorge. What had been told me by the inhabitants of Shaikhle and heard by me with incredulity was thus confirmed; it is not possible to penetrate into the gorge. Between perpendicular walls the stream issues from its mountain fastness, and in this gorge, as far as one can see, leaves not a foot-breadth of ground free from water, at least during the flood period, which lasts from the end of April to the beginning of October. In winter, as the inhabitants of Shaikhle say, one might perhaps penetrate into the gorge, but no one attempts it, since nothing is to be found there, except rocks and water. Only an expedition, expressly equipped

Digitized by Google

ISSUE OF KUM-ARYK FROM ITS GORGE.

[*To face p.* 148.

Digitized by Google

Digitized by Google

and organised for the purpose, and provided with fuel and supplies for men and horses for a sufficient length of time, could, in the late autumn or in winter, succeed in traversing the tortuous gorge and in accurately laying down its course and the courses of its contributory streams as far as the mouth of the Uch-kul in the Sary-jass. The configuration of the whole of this hydrographic system, as given in the forty-verst map, is very fragmentary and defective. The greatest defect is, that between Sary-jass and Inylchek, indeed, every connection of the river system is wanting. The perpendicularly cut walls of the Kum-aryk banks, after the stream has issued forth, are in some places perceived to be accumulations of huge rounded blocks piled without cement one above another to the height of nearly 300 ft. (100 m.). To produce such results the volume of water, flowing through the gorge must have been formerly much greater, as was the case in the post-glacial period, and this has continued during the emptying of the lakes, concealed behind the gorge, as these were one by one cut open by erosion working backwards.

The flow from the Sabavchy glacier, coming from the east, joins the Kum-aryk as a great turbulent mountain torrent, immediately after the latter river issues from its breach. In the background of the Kum-aryk gorge on its north side, the commanding snowy peaks of the Bostagh chain are seen, and behind them a still higher but rockier chain. I conjecture that the Koi-kaf valley cuts in between the two chains. As I was

Digitized by Google

able later to observe from other standpoints a broad side-valley branches off from the gorge of the Kum-aryk, shortly beyond its mouth, to the north-west, whose head in the much-levelled main chain west of the Bos-tagh group, is a wide glacier-trough among low, tent-shaped, snow-clad summits. That this side-valley (the Kirghiz call it Kara-gat) is without difficulty accessible from the high plain by crossing this ridge in front of it, and consequently that the depression in the main crest can be reached, is to me not doubtful. Probably the key to unriddle the whole mystery of the breach through the range, would be found to lie here. Though I now stood before the curtain, which veiled the yet unsolved part of the problem of the Kum-aryk breach, I had, owing to the great amount of work awaiting me on the northern side, no more time at my command for its solution. Of the longitudinal valley, where, on the east of the Bos-tagh group, according to the forty-verst map, the Ak-su or Kum-aryk must have its origin, I shall say something later. After the photographic survey of the interesting locality was completed, we retraced our steps to Shaikhle.

Digitized by Google

CHAPTER XII

THE SABAVCHY GLACIER

ALTHOUGH it was now high time to cross over to the northern side of the mountains in order to bring the remaining investigations to a conclusion, I was unwilling to leave this region without a glance into the still wholly unknown glacier-tract of the Sabavchy chain.

From the standpoint of Shaikhle, looking north, the mountain system is seen unrolling itself in a series of parallel longitudinal grades up to the plateau, all of which have to be crossed to get into the Sabavchy valley. Add the chain bounding the Sabavchy valley on the north, and these four chains will represent four parallel folds, bearing E. by 30° N. The nearest, a low range shaped into small domed summits, consists of variegated marls, resting conformably on highly decomposed, no longer recognisable dark slates—to all appearance identical with those constituting the two succeeding chains farther to the north. These are blue-green argillaceous sandy slates passing into red violet. The determination of their place must, however, be reserved till the specimens have been more closely examined.

Of the same material is built up also the third

Digitized by Google

chain. Here, however, are infolded grey limestones and thin beds of sandy-argillaceous composition resembling grauwacke. In the fourth chain these attain the dimensions of thick beds, alternating with layers of the blue-green slates. In these limestones is to be found here and there an accumulation of organic remains pointing to formation in a shallow sea. Herr Keidel had the good fortune to discover in these remains a well-preserved fauna of the uppermost carboniferous formation.

Traversing the first three chains and the longitudinal valleys intercepting them, the third and most important of which is called Terek, our road led us to the Kara-bury pass, 9,600 ft. (3,200 m.) high. This cuts through the third chain, which again, is known by the herdsmen of the region as Mansur-tagh. Looking down from the pass, one sees the Sabavchy valley stretched below, its lower course about a mile wide. On both sides there lie against the high, steep walls of the valley, green-mantled blunt ridges, round tops, and plateaux, composed of red and white sandy conglomerates and sandstones proper of tertiary age. These, covered everywhere with tufty grass, occupy also the floor of the valley, and there are divided by a labyrinth of perpendicularly eroded, dry ravines, 300—600 ft. and more deep. The anterior part of the valley is thereby rendered impassable. Only at one spot, by coming from the south-west, by way of a pass (Kysyl-kut) in these intersecting ridges, is it possible to cross this

Digitized by Google

labyrinth of the sandstone plateau and its eminences, and so enter the Sabavchy valley. The extraordinary ravine-formation witnesses to the volumes of water, once flowing through the valley—waters which had their origin in the enormous glaciers formerly developed in the valley. On many places these sandstones and conglomerates are overlaid with huge coverings of ancient moraine débris. On the slope of the chain on the left bank the tertiary deposits reach higher up than on the right bank, and are there buried under the ancient moraine débris to such extent that, only a few cliffs of the sandstones, are seen cropping through the verdure-clad masses of glacial and fluvio-glacial drift. The Sabavchy river runs close under its northern wall in an inaccessible gorge, scooped out perpendicularly in the sandstones.

The valley divides into two branches, the more northern of which constitutes the principal valley. This runs far to the east into the heart of the Sabavchy chain, which is wholly shrouded in ice. The southern branch, broader but shorter than the northern, ramifies into several arms from a wide trough, filled entirely with snow and nevé and surrounded by pyramidal ice-peaks; its copious stream unites in the outer valley with the main Sabavchy river. The bottom of this lateral valley, hollowed out like that of the main valley, in deep dry ravines, lies, on an average, 1,100 ft. higher than that of the principal valley and consists also of thick beds of glacier drift, overlaying the sandstones. One is surprised to find in this

Digitized by Google

dry southern region the surface of the old drift masses arrayed in beautiful thick Alpine meadows, whereon the inhabitants of the hot plain graze their cattle in summer. Even extensive pine-woods are to be seen where the slopes have a northern exposure. We first rested a night among the Sartian shepherds, high up in the lateral valley, and then made our descent into the main valley to where, at the end of the ridge, dividing the two valleys and running out towards the bed of the stream, there stands a fort, built by Yakub Beg—for what purpose is difficult to understand—now falling into ruins. From this spot I undertook the exploration of the Sabavchy glacier, and for this venture was favoured with a cloudless day—a rare event in this mountain chain. The thermal contrasts between this high snowy region and the glowing plain at its edge are excessive, and the consequence is pronounced condensation phenomena in the cold upland zone, or stormy outbursts, occurring almost daily.

The way to the snout of the glacier leads through a zone of tall, almost impassable brush. This is continued along both banks of the glacier, over moraine ridges and the débris heaps of the mountain walls, fencing the glacier to a length of six and a half miles with a broad dark belt, which often sends long tongues far up the mountain sides. Through a gatelike contraction of the valley walls one reaches the glacier, the tongue of which ends at a height of about 9,000 ft. (2,750 m.) There I was not able to make out

Digitized by Google

any signs of a recent retreat of the ice. Like the Inylchek glacier, the Sabavchy glacier is, over more than half its length, overlaid with a mountain-pile of moraine débris and blocks, presenting an uncommon variety of forms. The pile is still more stupendous than that on the Inylchek glacier. Yet, owing to the exceptionally dry climate, the blocks, often of enormous size, are held together by no sort of cement. Only loose sand and dry detritus-gravel lie between them. As a contrast to this phenomenon one observes on the mountain-walls thick beds of fine alluvial clay, wherein are embedded layers of boulders.

The ascent of the glacier, involving incessant climbing of ridges and crossing of valleys in the débris, costs no end of time and trouble. In several expansions of the valleys between the ridges there lie ice-lakes, some of considerable size. Judged by their depth, the mass of the glacier-ice must be of great thickness. Where it rounds off towards the mountain banks, the ice is very much crevassed, in part resolved into seracs.

Owing to the amount of time consumed in the attempt, I did not get farther than some six and a half miles up the ice valley, to a spot (10,800 ft.) where, from the north-east, the Sabavchy valley is joined by a large glacier valley, the frame of which is constituted of magnificent and exceedingly steep mountains. Between the mountain walls there descends, from a nevé plateau, stretching east-north-east as far as the eye can travel, a great glacier, the long tongue of which, completely

Digitized by Google

free from débris, glides in a beautiful curve out of the valley and joins the Sabavchy glacier, presenting a splendid spectacle. The background of the Sabavchy valley consists of a double range of ice-mountains, 19,000 ft. high and upwards, showing hardly a spot of bare rock. The distance from the point I reached to the valley's head, I estimated at over eight miles. Considering its situation in a valley that opens to the south-west and lies near the outskirts of the hottest and driest region of the Tian-Shan, it is astonishing that the Sabavchy glacier has still at this date, nevertheless, a total length of at least fourteen miles (twenty-two versts). Its massive shield of débris protects it from liquefaction. The dimensions, formerly attained by it are indicated by the old moraine remains, well preserved in the middle reach of the valley, which rise 1,300 ft. (400 m.) up the enclosing walls. The material of the environing walls of the valley consists in the main of the often-mentioned blue-green phyllite-like slates, which are interstratified with argillaceous sandy layers and grey limestones. In consequence, however, of their immediate neighbourhood to the granites, these grey limestones have, through contact, grown crystalline. The zone of the granites extends, as far as I could follow it, more than nine miles (fourteen versts) up the glacier valley, and includes granites of vastly varying composition, syenite and gneiss. A dense black metamorphic eruptive rock which, farther back, I noted as one constituent in the granite zone, but of which I was able to

Digitized by Google

SABAVCHY GLACIER, DEBOUCHING OF A LATERAL GLACIER FROM NORTH-EAST.

[*To face p.* 156.

Digitized by Google

Digitized by Google

collect only in the moraine some fragments, appears to be of diabasic nature. The farther one penetrates into the valley, the more does one observe in the moraine débris fragments of black limestones, slates, and white and reddish marbles. It may thence be concluded that, as in other parts of the Central Tian-Shan, so also here, this series of rock constitutes the highest parts of the mountain chain at the head of the valley. The chain bordering the glacier on the north, presents a remarkable variety of forms and extremely steep peaks. Behind it appears another still higher chain. According to the forty-verst map the source of the Kum-aryk, or, as it is there called, Ak-su river, should lie between the two, a representation incorrect in any case. If there is a longitudinal valley enclosed between the two chains, as undoubtedly there is, then, according to reasons explained hitherto, it could be only a lateral valley of the Kum-aryk. Whether this longitudinal valley is identical with the Koi-kaf valley, visited by me later, I was unfortunately not able to ascertain (*vide* farther on). In any case, however, I remarked distinctly, between the so-called Ak-su valley of the forty-verst map and the Sabavchy valley, yet another valley, running in the same direction. It appears to be but short. It is known to the people of Shaikhle, who distinguish it by the name of Kasalai.

Digitized by Google

CHAPTER XIII

THE KUKURTUK VALLEY

I POIGNANTLY regretted that the big programme of the year's work, still outstanding, did not allow me three or four days more to complete my survey of the Sabavchy glacier and make a closer inspection of its lateral valleys.

The return route from Kuchi was somewhat varied, leading us through the northern spurs of the tertiary mountain chain, spoken of on the way to Kum-aryk (*vide* p. 145). We crossed the skirt of the mountain chain through the valley of Darvasse-su, a highly expressive name, seeing the valley stream issues through a gate-like contraction in the marl walls into the broader part of the valley ("Darvasse" signifies door). The springs here, too, numerous and strong, can derive their origin only from the ooze-water of the higher mountain ranges stretching northward. Withdrawing from this valley, our route lay on the verge of this marl mountain chain; thence we crossed the shingle-covered, desert plateau in a south-west direction, and again reached the oasis of Kukurtuk. Thence our way to the entrance of the Kukurtuk valley once more led us some sixteen and a half miles (twenty-five versts) over similar desert ground,

Digitized by Google

At the first glance into the valley one is surprised at its appearing to be shut in by a comparatively low and snow-free chain. In order, however, to the understanding of what is to follow, I must at once lay stress on the fact, that this apparent enclosure of the valley is not the real one—not the main ridge forming the watershed between south and north, but only a chain, running at a short interval in front of the main ridge and hiding it. In the neighbourhood—namely, at the Kaiche pass —there occurs a ramification in the main ridge. While the latter pursues its west-south-west course, the diverging chain takes first, in the shape of a blunt ridge almost free from perpetual snow, a south-south-west direction as far as to the axis of the Kukurtuk valley; thence, however, it assumes, though of course with many turns, a direction averaging north-west, forms the head of the Kok-rum valley, and, near the Bedel pass, again joins the main ridge. With its transition into the north-west direction this chain rears up strikingly to far above the height of the main ridge, and forms a series of grand peaks with considerable glaciers.

At the entrance of the Kukurtuk valley, after passing a zone of fine-grained conglomerates, we again came upon the inevitable *Schwagerina*-bearing lime-stones. Stratified pudding-stone (*Deckenschotter*) lying in undisturbed position covers a prodigious area in the widened lower course of the valley. The river, which on entering the valley runs still hidden under drift, springs

Digitized by Google

all at once to view in copious volume a mile higher up. In these conglomerate-like accumulations, whose appearance again and again distinctly points to their glacial origin, the river has carved two longitudinal terraces (*Längsstufen*), one sixty to sixty-five feet above the other, and cuts its way in a regular, often winding cañon with alternating angles.

Our way led us for hours far up this cañon. The cañon character of this landscape is explained by the dry climate, here prevailing, and the extraordinarily disintegrated condition of the rock of the valley-walls, which accordingly absorb the whole precipitation, thus making lateral excavation impossible. The river, rapidly cutting its way deeper and deeper, has already begun the formation of a new terrace.

None of the southern Tian-Shan valleys, hitherto visited, presents a spectacle of disintegration in the enclosing walls, similar to that exhibited in this one. The stratigraphic relations are thrown into such utter confusion, that it is difficult to form an adequate idea of the grotesque chaos. Direction and angle of the dip of the rock-series changes every ten steps. Certain layers you first see lying below, appear after a short interval perched high on top, without its being possible to determine which is the infolded and which the infolding rock. Light and dark grey limestones alternate with yellow-white, marble-like limestones and blue-green slates, here of more argillaceous, there of more sandy, character. In general, their

Digitized by Google

petrographic character varies with extreme frequency. They are, moreover, in an extraordinary degreé crushed, shattered, and crumpled. Sometimes the different series of rocks form horizons some miles broad, sometimes hardly more than thirty feet. In the dark limestones we collected a very rich upper carboniferous fauna, comprising three hundred specimens of fifty species. At the very entrance of the valley we were struck by the total absence of crystalline material among the drift and alluvium, and nowhere throughout the course of the valley could we find crystalline fragments. We thus received confirmation of the fact, which I had suspected ever since ascending the Janart pass, in glancing into the there very narrow zone of granite (*vide* p. 142)—namely, the *complete effacement of the crystalline zone between Janart and Kukurtuk; farther to the west, at least, beyond the Bedel pass, it no longer crops up in the main watershed and on the south slope of the mountain chain.* On the other hand, the crystalline formations farther north appear to be continued to the west in the mighty Borkoldai range (of which more later).

On marching into the valley a short earthquake, accompanied with a rumbling noise, was experienced. In this region of severe dislocation that is a characteristic phenomenon. The valley has a total length of sixty versts. Accumulation of ancient moraine débris was observable at the mouths of several lateral valleys, now no longer holding glaciers. Remains of such débris could

Digitized by Google

be traced also in the principal valley up to a considerable height on the mountain walls. Even in this not easily accessible valley we found on the threshold of an upper stage of it a primitive barrier, erected across it by Yakub Beg in his insane Russophobia; behind the barrier the water of the stream was formerly banked up into an artificial lake.

In consequence of the information received in Uch-Turfan, it was originally my intention to make with the caravan for the north side of the mountain chain by way of the Kukurtuk valley and the pass, that crosses the main ridge at the head of the valley. It was not long, however, before I became aware of the impossibility of such a feat. I therefore resolved at least on climbing the pass by myself, and there obtaining more accurate orientation respecting the structure of the mountain chains. Despite unfavourable weather, I was able, starting from our second encampment, at about 9,000 ft. (2,820 m.), to successfully carry out this resolution. In the upper course of the Kukurtuk valley, throughout a stretch of some miles, there occur contractions in the shape of narrow gorges. The high rock-walls, between which the stream leaves there not an inch of unoccupied margin, frequently approach to within fifty feet of each other, and notable hollowings of the rock may be remarked. Yet, higher up on the rock-walls, one may frequently perceive *roches moutonnés* and striation due to the action of ice. This becomes intelligible when,

Digitized by Google

higher up the valley, one contemplates the colossal remains of old morainic drift, into which the bed of the river is there cut. Several of the affluent lateral valleys present considerable sections, and in spite of their present aridity, the streams, that they once held led to the hollowing out of basin-like cavities in the principal valley. Next, at a threshold-like rise in the valley, comes another contraction, which Yakub Beg turned to account in again damming up the water into a lake. Shortly thereafter the main valley becomes impassable. It runs steeply, as a winding gorge, carrying copious water, in a north-north-west direction. Farther advance toward the pass must therefore be made through a lateral valley, dry at that season, running to the west and then to the north. That again soon becomes impassable; the traveller has no alternative but to push his way upwards along the very steep and high walls. In this wise he again attains the height of a ridge, and soon reaches a breach, cut into the branch chain formerly mentioned (p. 159), which diverges from the main ridge near the Kaiche pass. This branch chain splits in turn into two arms, divided from each other by deep, snowy, high-lying trough-shaped valleys, which send their waters through steep *couloirs* into the main valley. The traveller has therefore the task of making the steep descent and then steep ascent of 800—1,000 ft. twice. Next, passing through another gap in the last secondary chain, he reaches the shallow channel, occupied by a small glacier draining to the main

Digitized by Google

valley, through which he attains the pass proper. And on a passage like this, Yakub Beg's Russophobia deemed further fortification needful!

The walls enclosing the upper valley present at first an alternation of rocks, similar to that at lower levels. Yet, immediately after the ramification of the lateral valley, through which the ascent is made, highly decomposed black slates (*Tafelschiefer*) occupy a very broad area, while on the highest region, on the other hand, the often-mentioned blue-green slates, constantly changing in their constitution, predominate alone and form the summit of the pass (over 14,000 ft.; 4,400 m.), as also the blunt, nevé-covered heights environing it. Immediately before entering on this very thick horizon there lies intercalated, after the black slates, a zone of about 650 ft. of dark oolitic limestones. The whole series trends E. by 20° N., and dips very steeply, now to the south, now to the north. Now here, far and wide, there was no crystalline rock observable, thus demonstrating the important fact, already mentioned, of the effacement of the crystalline zone. On the pass we became aware, that the north side is easier to ascend than the south side, the slopes being less steep, lying much less under snow and completely free from glacier ice—an abnormal phenomenon. One sees, also, not more than 2,500—3,000 ft. below the summit of the pass, beautiful Alpine meadows. A chain, built of dark slates, running approximately parallel to the main ridge and trending westwards toward the Börkoldai chain,

Digitized by Google

concurs with the contracted wall, surrounding the pass itself, in obstructing the view of the higher mountains to the north. The view is only grand rearwards, to the south-south-west in the direction of the western part of the branch chain, above referred to (*vide* p. 142), running to the Kok-rum valley. This branch chain presents a series of very steep peaks, adorned with extensive glaciers. Its summits reach to considerably over 16,000 ft.

Two striking facts, hard to reconcile with one another, were matter of thought to me in the Kukurtuk valley. With the exception of a few spots there is no grass growing in the whole of the principal valley; forest is completely wanting. The Janart valley, on the other hand, running near and parallel to it, is comparatively rich in both. In contrariety with these data, the Kukurtuk valley receives a comparatively copious supply of precipitation, thunder-clouds gathering over it continually. From the neighbouring valleys, contrariwise, such clouds are absent. From Uch-Turfan and onwards this fact could be noted.

Digitized by Google

CHAPTER XIV

FROM THE KUKURTUK VALLEY TO THE BEDEL VALLEY AND OVER THE BEDEL PASS TO THE NORTH

THE passage by way of the Kukurtuk pass being impossible, the only road, available for the caravan, was that by way of the Bedel pass. The month of June was nearing its end, and there was no time to lose. Not wishing to follow the well-known caravan route running through the steppe to the Bedel valley, which would have added nothing to my knowledge, and in order to gain further insight into the structure of the mountain chain, we hurried, after clearing the Kukurtuk valley and taking a short passage across the waste plateau, in a western direction and entered a broad, dry valley called Chon-Jar, which cuts westwards and south-westwards into the spurs of the mountain chain. The limestones of the walls of the valley contain organic remains, pressed beyond identification.

On its contracting, the valley, which has hitherto presented only a scanty steppe vegetation, assumes an Alpine character, with slopes of fine, rich Alpine meadows. Yet nowhere in the channels

Digitized by Google

was running water to be seen. After mounting a grassy pass to the west, we descended into a wide, cauldron-shaped valley, Balter-Yailak (9,500 ft.; 2,900 m.), the floor and slopes of which were clothed with luxuriant Alpine meadows. It is formed by the convergence of four steep, high valleys cutting through high limestone ridges of the environing walls. But, nevertheless, here too, with the exception of a distant spring, no running water was to be found. Obviously the steep-piled layers of the surrounding walls soak up the precipitation, which runs away at no great depth in the loose drift soil of the declivity and the floor of the valley. In no other way could one explain the dense growth of grass in these Alpine meadows. After spending a night with the Kirghiz of the valley, we followed across Alpine meadows the broad, dry bed of the main stream, keeping a southerly course. Climbing a grassy ridge about 500 ft. high, we descended into a hollow valley of altogether similar structure with that of Balter-Yailak. The bed of the stream, then dry, deepened into a ravine, and cleft a gate-like gap through the separating wall, thus communicating with the Balter-Yailak valley. The beds of the main streams of these two cauldron-like valleys unite to form a deep channel, which, through a break in the east wall of the Balter-Yailak hollow, strikes steeply down in a south-east direction. Climbing the southern wall of the second cauldron, we reached a pass, Kok-belys (10,500 ft.; 3,250 m.). Its summit affords a commanding view of the valley-

Digitized by Google

ramifications, which cleave the mass of the mountain chain between the great transverse valleys of Kukurtuk and Kok-rum, and whence proceed, towards the Taushkan-daria, only two great channels: Mendagyl-bulak and Tanke-sai (*vide* p. 144); and these, too, carry water only periodically. It was interesting to me, to observe that the main affluent of the Balter-Yailak is formed by the bed of a stream, then dry at its point of confluence, which takes its rise in the north-west on the high chain of glacier mountains stretching to the Kok-rum valley (*vide* p. 159). As is reasonable to suppose, a strong current is said to run through the upper course of the valley of this stream, likewise named Balter and also Ak-bel. But this current, again, does not reach, at least not superficially, the cauldron-shaped basin of Balter-Yailak. These valleys, predestined by situation and structure to the possession of a plenitude of water, offer a striking demonstration of the fact, that it is not so much evaporation, as the permeability of the drift floor that is to blame for the scanty supply of water on the south slope of the Tian-Shan. From the Ak-bel valley a high glacier-pass is said to lead into the Kok-rum valley; this would explain the name of Ak-bel, meaning "White pass."

Descending southwards from the pass of Kok-belys, we entered a valley called by the Khirgiz Khurgo, draining to the Kok-rum. Its broad water-channel was then likewise dry. In its lower course the valley contracts,

Digitized by Google

breaking through a range about 1,200 ft. (350 m.) high, of conglomerates of fine material, and cleaving a chasm with almost perpendicular walls. These conglomerates follow the strike of the higher limestone ranges, and, as a many-furrowed, eroded range raised in flat arches, they form the skirt of the mountain chain as far as the Bedel valley, and thence beyond in a westerly direction, as far as they could be recognised.

Soon after, the Khurgo valley was seen to join the Kok-rum valley. From a projecting terrace near the point of junction, a comprehensive view is obtained of the winding course of the Kok-shaal and Taushkan-daria, and of the mighty, but so little known mountain ranges walling in its southern bank (*vide* p. 119 *seq.*). These ranges mount to 11,500 ft. (3,500 m.) above sea-level, and, as could be seen from here, carry notable glaciers (see also p. 120). From here was clearly perceived the deep narrow saddle of the Sary-bel pass, and the broad plateau-like depression of the Dungaretme pass. We made a steep descent to the bank of the rapid, copious Kok-rum, which, as already mentioned, has its origin in the richly glaciated secondary chain (p. 159). At its head, too, the Kirghiz told me, were great glaciers. This statement I was myself able to substantiate and to fix photographically later on, from a height I ascended in the background of the Bedel valley.

We soon again quitted the Kok-rum valley, crossed the high desert plateau in a south-west

Digitized by Google

direction, and reached the outlet of the Bedel valley at the place of caravan encampment, Uy-tal. The picket of the same name, a Chinese fortification with a barrier across the valley, where examination of the caravans is made, lies eight miles (twelve versts) farther back in the valley, and was not reached till next day.

The Bedel pass is, with the exception of the Musart pass, the only one possible for caravans between the north and the south slopes of the Central Tian-Shan. While the Musart route leads to Kulja, ministering only the Chinese traffic, the Bedel route, on the contrary, disemboguing at Przhevalsk, serves the Chinese-Russian commerce. It has been crossed by Przhevalski, Pjevtzoff, and Krassnoff. These, and also Kaulbars, have published some information respecting the route. I shall, therefore, in this preliminary report say but little of this very interesting thoroughfare, and confine myself to those of my observations, which refer to data hitherto either very little known or altogether unknown. By its clear waters, the copious river shows at once that there is but little glacier-formation to be expected in the valley. The road in the lower part of the valley, on the right bank and aloof from the river, the bed of which is impassable, leads through deep ravines in the enormous boulder deposits of the valley-bottom. Here, therefore, more than elsewhere one has the opportunity of appreciating the extraordinary depth of these piled-up masses. Soon after leaving

Digitized by Google

the here uncommonly broad belt of conglomerates, argillaceous-calcareous, sandy slates of unusual piebald colouring appear, carved by severe erosion into cones of blunt pyramidal shape. So advanced is their decomposition that they break in pieces at the slightest touch. They proved to be void of fossils. Continuing our way up the valley, we reached a mighty horizon of more solid, grey-blue slates, evidently relating to the fragile formations in the anterior valley. As to their geological position, however, no final judgment can for the present be pronounced. They are set at a very steep angle; important disturbance and great irregularity is observable in their stratification. With them alternate, farther up the valley, other slates, now of sandy-argillaceous, now of calcareous-argillaceous constitution. They appear also, however, each in peculiar complexes and farther ahead, were relieved by fine, silky, dark slate (*Glanzschiefer*). To this series of rocks, which has a breadth of about ten miles, succeeds a zone of about two and a half miles in breadth, consisting of light-coloured, marble-like limestones, enclosing beds of red limestone. On the side of incidence they are resolved into chaotic rock-series, and on the opposite side of the valley they form almost perpendicular, unbroken walls. The south-western exposure favoured their demolition. On the limestones follow the same blue-green slates, of which a narrow zone was noted previously in the Janart valley (p. 141 *seq.*), and which again in the Kukurtuk valley assume enormous development

Digitized by Google

(p. 164), and are here in the Bedel valley still more mightily developed. They form, here and onwards as far as the pass—that is, for more than thirteen miles (twenty versts)—the enclosing walls, but here, too, frequently change their petrographic character. Sometimes they enclose laminated, argillaceous-sandy layers, resembling grauwacke, often also fine, dark slate. Only once more is this series of rock interrupted by a small zone of dense, brown limestone; the amount of warping, crushing, and disorganisation of the whole stratified system surpasses all conception. The enclosing walls, built of this series of rock, are distinguished by bluntness of form. Old igneous rock was nowhere observed, nor were any fossils discovered. But eruptive rocks of diabasic nature were noticed in some places. The occurrence of such does not, however, satisfactorily explain the extraordinary disturbance in the sedimentary rocks.

In the second third of the valley, which is altogether about thirty-six miles (fifty-five versts) long, at a spot where before the ascent of the pass a camp was pitched, I climbed a high dome, towering up between the principal valley and a lateral valley, running in from the north-east. Thence I was able, as already related (p. 169), to observe and photograph the richly-glaciated background of the Kok-rum valley. There, shooting up at the valley's head, a magnificent ice-peak overtops by several hundreds of yards the highest level of its environment, reaching

Digitized by Google

a height which may be reckoned at 17,000 ft. (5,200 m.). From the Kok-rum valley a heavily ice-clad pass leads into the already-mentioned lateral valley (*vide* p. 168).

From the height I had gained I was also able to determine that the main ridge, trending north-north-east and forming, in a broader sense, the enclosing right wall proper of the Bedel valley, was not only many-peaked, but was very thoroughly clad with glaciers, draining mainly to the north-west into the important, deep-cut, unexplored, longitudinal Karakol valley, sunk between the Borkoldai chain and the main ridge. From the middle of the Bedel valley a short, blunt, but high lateral chain, wholly covered with nevé, is seen stretching in an east to west direction towards the main ridge, which trends north-north-east. From the heavily glacier-clad southern side of the angle, formed by the junction of the two chains, descends the Chalmaty valley. Its stream, as reported by the Kirghiz, is the most copious and most rapid of all the streams on the south slope of the Kok-shaal-Tau. It debouches opposite the Aul Safar-bai (p. 122) into the Kok-shaal. At the head of this Chalmaty valley there rises a very high and steep mountain of massive breadth, overtopped in this part of the Tian-Shan only by the so-called Petroff peak (pp. 138, 143). Presumably it is the mountain figuring on the forty-verst map under the name of Usun-gush. From the Bedel pass I was able to take a telephotographic likeness of it.

Digitized by Google

The flat saddle of the Bedel pass (about 13,000 ft.; 4,300 m.) is situated, not at the head of the Bedel valley, but somewhat to the west of the pan-shaped trough (Karmulde) at the head of the valley—this Karmulde containing a small glacier. The view from the pass is interesting and varied only towards the south. On the north side the outlook is cut off by the Ishigart-Tau, a chain with a quite uniform series of peaks. All that is striking in that direction is the surprisingly important glacier development of the south *versant* of that chain.

The stratigraphic complex of the south side is continued on the north side of the Bedel pass. Hence it is the extraordinary difference in the climatic conditions of the north and the south slopes of the great chain, under which moist weather and abundance of water prevail on the north side, and also the extraordinarily powerful glacial action, to which the north side was subjected in former times, that explains the great difference in the relief and in the character of the landscape between the north and the south *versants*. I must reserve for the fuller report the detailed elucidation of this subject. In a basin-like expansion of the northern Bedel valley, tertiary sandstones were observed at a height of about 11,000 ft. (3,300 m.); they are slightly dislocated. The very copious northern Bedel river soon scoops out a deep bed in the steeply inclined limestones and sandy argillaceous slates in its course, flows in a narrow ravine, and, shortly before the track reaches the broad,

Digitized by Google

flat saddle, leading into the Ishtyk-su valley, turns between high, perpendicular walls of rock sharply to the east, disappearing from view in an inaccessible cleft. Through the channel of the Ishtyk-su its waters reach the Sary-jass, and are then by the Kum-aryk conducted to the south side—a remarkable career on the part of this river, when it is considered how much more easily it might have reached the region of the Naryn system.

Digitized by Google

CHAPTER XV

THE WATERSHED BETWEEN NARYN AND SARY-JASS AND THE PASSAGE OF THE SOUKA PASS TO LAKE ISSYK KUL

AFTER crossing the flat pass of Ishtyk (about 11,500 ft.; 3,500 m.) one beholds for the first time the Borkoldai chain, the eastern part of which, here in full view, presents indeed a plenitude of glaciers, but is not particularly steep in its build. It does not convey the impression of mighty altitude and imposingly bold character, such as is felt in the presence of the magnificent, ice-mailed, giant peaks of the western part. Not till after the descent into the regions of the headwaters of the Kara-say does one see this chain unfold itself with complete magnificence, beyond all expectation and conception. It is remarkable how little of this chain is hitherto known. Or˘ · Kaulbars has appreciated its significance. The peaks of this chain, attaining possibly to a height of 19,500 ft. (6,000 m.) or more, display a beauty and boldness of structure, a ruggedness and variety in their snow mantles, that can be matched in but few parts of the Tian-Shan. One of these grand mountains was reckoned by Kaulbars to be the highest in the chain, and baptised by him Mount Catherine,

Digitized by Google

MOUNT CATHERINE (ABOUT 19,500 FT.), IN THE BORKOLDAI RANGE, TAKEN FROM THE AK-BEL PLATEAU (ABOUT 13,000 FT.).

[*To face p.* 176

Digitized by Google

Digitized by Google

of which I took a telephotographic likeness. It is, however, considerably exceeded in height by some mountains, towering farther to the west and others farther to the east in the same chain. No less surprising, especially in respect of nevé and ice-covering, as well as extent of glaciers, is the Ak-shiriak chain, trending north-north-east. The traveller sees it continually to the east of him, while he pursues the road from the region of the head waters of the Kara-say to that of the Yak-tash. In this chain, which altogether attains a length of about thirty-three miles (fifty versts), but little rock is seen cropping out to view. The greatest part lies hidden under a cloak of firn and ice. The abnormal feature, however, in the case is this. The nevé-covered slope and the course of the great glaciers—among which the fine Petroff glacier, with a length of thirteen miles and giving rise to the Yak-tash river, takes the first place—have a precisely western direction towards the Syrt plateau of Ak-bel, whereas the chain to the west of this plateau, the Yulushu chain, though its flanks are directed to the east, shows no glacier formation. In no part of the Northern Tian-Shan, in which, with but slight exceptions, the presence of snow and ice is uniformly dependent upon a northern and eastern exposure of slope, have I encountered on a large scale any instance of a like nature. An explanation of this phenomenon can only be found in the fact, that the moist winds have a prevalent bias in favour of certain directions.

Digitized by Google

To the Ak-shiriak chain, whose peaks attain to only 15,400 ft. (4,500 m.), overtopping the Syrt plateau by only 2,300—2,600 ft. 700—800 m.), falls the rôle of water-shed between Naryn and Sary-jass—*i.e.* between Syr-daria and Tarim. This rôle, however, it plays but defectively. Very much effaced is the watershed between the many-branched head-water region of the Kara-say in the west and the Ishtyk-su in the east, as well as the watershed between the Yak-tash, flowing westwards, and the Yir-tash, flowing eastwards. On the flat marshy Syrt plateaus, on which the rivers just mentioned take their rise, the waters from the surrounding glacier chains flow and trickle over the shingly fluvioglacial soil in all directions. They thus go to the formation of a large number of smaller and larger lakes, lying flatly embedded amid the greenery of the Alpine meadows, as also of extensive swamps. In this wide region the water courses ramify, change direction, and lose themselves in the swamps to such a degree that a demarcation of the territories, drained by each respectively, would be involved in no small difficulties. How stagnant this domain is, may be gathered from the fact that in the beds of the uncommonly numerous and copious streams of the plateau hardly anything is to be found but fine gravel and sand. To drag any heavier material along with them surpasses the power of these lazy waters. The lower parts of the mountain chain are so wrapped in débris, that the steeply inclined layers of limestone and

Digitized by Google

slate frequently emerge out of the meadow-lands only a few yards above the débris. Everything here has acquired a soft, rounded form. At a remoter time, however, the streams from here obviously pursued a more energetic course through the valley. But the enormous masses of moraine débris, which the converging action of the glaciers, flowing in hither from all sides, piled up, got gradually washed away in all directions. This led to a general levelling and almost complete effacement of relief. And hence to-day the water-shed between east and west, between south and north, seems hardly any longer recognisable.

In the head water region of the Kara-say and in the immediate neighbourhood of the glaciers, at a height of about 12,000 ft. (3,700 m.)—that is, somewhat higher than the locality near the Chatyr-kul lake, where Mushketoff first found them, tertiary red sandstones and conglomerates were observed. These were further to be detected at a greater distance westwards on the slope of the Jitim-Tau, at an approximately equal height. One can hardly be wrong in concluding, that these strata were deposited in large mountain lakes, which at one time lay embedded here, lasting for long geological periods, and of which the numerous tarns, that dot the plateau at the present day, are the remains. The walls surrounding the valleys, taken in a broader sense, both of Kara-say and of Yak-tash, are built of granites of very different character. Between the Ishtyk

Digitized by Google

pass and the Kara-say Herr Keidel found in the calcareous cliffs Devonian fossils.

The route we pursued does not coincide entirely with that followed by the caravans, and from the head waters of the Yak-tash it diverged altogether from the caravan route. Whereas the caravans take thence a north-west direction and avail themselves of the easy Barskoun pass to cross the Terskei-Ala-Tau chain, we turned out of the Uechy valley (12,000 ft.; 3,650 m.), a feeder of the Yak-tash, towards the north, and crossed the difficult Souka pass (14,000 ft.; 4,250 m.) Whereas the approach to the south side of this Terskei-Ala-Tau and to the passes which cross it is, at any point along sixty miles of its length, easily accomplished over the gradual slope of the Syrt plateaux, the northern side of the chain falls away very steeply to the Issyk Kul basin.

From the high plateau, rising up to the east above the Uechy valley, there is a grand view of the enormous wall of the Terskei- (or Kirghiz-) Ala-Tau. The important glacier system, adorning even the south side of this mountain chain, far exceeded my expectations. The very extensive plateaux forming the waterparting ridge, lie under a continuous and immense sheet of ice. The high peaks, some of them mounting to about 18,000 ft. (5,500 m.), are dressed in beautiful glacier mantles, whose terminal tongues reach far into the Syrt. All this was fixed in tele-photographic views. The southern edge of the

Digitized by Google

chain consists, as already related, in great part of plateaux, and comparatively few peaks overtop these crestforming glaciated expanses, which, however, are intersected at intervals by deep breaches. The western part of the chain, adjoining the passes of Kerege-tash and Tosor, and the most easterly part, constitute the exceptions to this character. There the relief shows very important, boldly shaped peaks. In the central part, therefore, on the south side, plateau-formation prevails. The rim of the ranges towards the north slope, on the contrary, appears resolved into an almost uninterrupted sèries of firn-covered peaks, displaying the richest variety of forms and the utmost steepness. The defile of the Souka pass cuts through the mighty chain at a place where, on both sides of the pass-route, the eye lights on magnificent mountain scenery. On the west side, more particularly, important glaciers empty into the trough of the defile. The ascent of the pass was a severe strain for the caravan; still more severe was the descent on the north. At a slight depth below the summit of the pass one reaches a lake of complicated outline, which was then frozen, embedded in a valley, or rather, hollow, between the promontoried slopes of a girdle of bold, ice-clad peaks. Out of the intervening gorges glaciers are seen, pushing their riven tongues into the bays of the lake. It is a splendid spectacle. At the time, however, when we crossed the lake, the deep mantle of snow, covering the ice, and the ice itself, were both very

Digitized by Google

much softened, and the passage with the caravan was hazardous. The day before, a Kirghiz caravan on its way up to the pasturing places of the Kara-say here lost some hundreds of sheep. The wildness and magnificence of this mountain region is exceeded in the Tian-Shan only by the mountains bordering the Inylchek glacier.

On the south side of the pass dark limestones are the prevalent constituent in the enclosing mountain walls, and they assume a schistose character. On the pass itself there extends a thick granite zone, consisting of granites of very varied composition.

Towards the north there next follows a series of dark, highly metamorphic, argillaceous slates, and thereafter again come the dark limestones. Thereupon granite appears, with crystalline slates, as alone predominant, constituting the environing walls of the valley as far as the neighbourhood of Lake Issyk Kul. The descent from the pass, across steep declivities, over enormous accumulations of moraine-débris and rock-fragments, is not easy, but the engirdling mountains are splendid, as is also the valley itself. The wealth of form in the environing walls of the principal valley, the magnificent glacier scenery of the lateral valleys, the richness of wood, water, and Alpine meadows, all unite in distinguishing the Suka valley as one of the grandest Alpine valleys of the Tian-Shan.

A chain of very varied form, carrying small glaciers, and running in front of the main range

Digitized by Google

of the Terskei-Ala-Tau, parallel to it, is not entered in the forty-verst map.

Masses of ancient and now green-mantled moraine-débris form the varied floor of the outer valley. These masses, which are there spread out far and wide by the action of water, reach near to the south shore of Lake Issyk Kul. Old terminal moraine-walls are found in the middle part of the Souka valley. In the anterior part they still attain a very considerable height, and so completely block the valley, that the track is carried over them. Behind them there formerly lay lakes. Also, the lower course of the valley, through the mountain chain, once held a lake, and that of very great compass; there the river now breaks through huge banks of loose, red tertiary sandstones, which are overlaid by considerable accumulations of younger moraine-débris. In these, two ancient river-terraces are visible; they follow the lower course of the river, where a third terrace is in process of formation.

The crossing of the mountain chain from south to north took us seven days. On July 9th we arrived at Slivkina, now Pokhrovskaya, on the south shore of the Issyk Kul, and proceeded thence to Przhevalsk and Karkara. Though some objects in our programme were only half effected, or altogether untouched, the investigations on the south side of the great chain had nevertheless consumed more than the anticipated time. In view, therefore, of the far-advanced summer, I was under apprehensions that the indispensable

Digitized by Google

labours on the north side might fail of satisfactory completion, especially should the weather prove as unfavourable for exploration as had been the case the previous summer. However, I may as well say at once that these apprehensions were happily not realised. Steady weather, such as, according to the reports of the natives, is seldom experienced in these regions, favoured my investigations, and allowed the prosecution of my work in the mountain chain till towards the end of the year. Much, therefore, if not all, which I had set my heart on doing, I was able to accomplish in a satisfactory manner.

Not to swell this report, which has already assumed unexpected dimensions—to a compass which might impede the printing of it, I am unfortunately under the necessity of restricting the account of the further progress of the expedition, and of its very important and fruitful labours, to a mere cursory review.

Digitized by Google

CHAPTER XVI

SURVEYING ON THE SEMENOFF AND MUSHKETOFF GLACIERS

In Karkara and Narynkol (Okhotnichi) it became necessary to organise the expedition with a view to a sojourn in the highest regions of the mountain chain, and in order more particularly to establish its commissariat on a sound basis, I had to engage suitable porters in sufficient number, and to buy fresh horses and many other necessaries. Herr Keidel, meantime, with a part of the expedition, made his way through the valley of Ulluk-Karkara, and crossed the Sart-jol pass (12,200 ft.; 3,720 m.) into the Kok-jar valley, which in its upper course is known as Kuberganty. There and in its lateral valleys he was to pursue geological explorations. He there collected a fauna of the lower carboniferous formation. Thence he next crossed the Kashka-tyr pass (12,000 ft.; 3,700 m.), and entered the Sary-jass valley. Near the mouth of the Myn-tyr valley he marked off a basis about a mile long, which he fixed by geographical determination, and thence he once more fixed the height and position of Khan-Tengri and the most important peaks surrounding it. After precise calculation of these data, and those

Digitized by Google

of the measurements of Herr Pfann, taken the previous year from a different basis (*vide* p. 42), I shall be able to produce trustworthy figures in respect of the height and situation of the culminating peak.

With the bulk of the expedition I set off from Narynkol on July 19th, made my way through the great Kapkak valley, which I have already cursorily described, crossed the Kapkak pass, and at once turned in the direction of the upper course of the Sary-jass, where, a little below the snout of the Semenoff glacier, I ordered the principal encampment to be set up. The first and most important task for me was to procure compensation for the heaviest loss of the foregoing year (*vide* p. 88) and in thirteen sheets of the size of 8 by 10 English inches, replace the great telephotographic panorama of the Central Tian-Shan, which had then been taken from a standpoint admirably fitted for the purpose.

After a few days' rainy weather, we were favoured by a calm, accompanied by clear atmosphere, and the work was eminently successful. Meanwhile, triangulating upwards from his basis, Herr Keidel had likewise arrived at the chief encampment, and then began to lay the triangular network farther above the Semenoff glacier. In nine days he completed this work, which at last, and just at the highest part of the glacier, was very much impeded by bad weather. The topographic detail was secured by photogrammetric views. This period of time I turned

Digitized by Google

to account in making a closer investigation of the main glacier and its most important tributaries. From a bivouac situated thirteen miles (twenty versts) up the glacier, and standing about 13,000 ft. (3,950 m.) high, between two moraine lakes on the right moraine bank, I penetrated into a wide ice-valley running eastwards. I climbed up its broad, nevé-covered saddle (14,400 ft.; 4,400 m.), which I had nearly approached (*vide* p. 80) the year before, when going up the western Bayumkol glacier. It gives access to the highest nevé of the last-named glacier, and I accordingly name it the Bayumkol pass. The exceptionally favourable condition of the firn covering induced me to climb also a snow-clad summit to the north of the pass, rising to a height of about 15,400 ft. (4,700 m.).

From both heights I obtained welcome additions to the previous year's observations on the structure of the walls, enclosing the Bayumkol valley, and thus, encircling the Semenoff and Mushketoff glaciers, all of which were recorded in a number of views and panoramas.

From a bivouac on the middle moraine of the chief glacier (12,500 ft.; 3,800 m.), some ten and a half miles (sixteen versts) from its tongue, I made the ascent of a peak, rising on the south edge of the Semenoff glacier to a height approximately of 15,700 ft. (4,800 m.). Its situation is particularly favourable for the observation of the south-western slope of the pyramid of Khan-Tengri. It also afforded instructive insight into the structure of the grand group of mountains, ranged immediately

Digitized by Google

in front, on the south-western side of Khan-Tengri, as also of the lateral ice-valleys of the main glacier, which have their outlet in the neighbourhood. By means of the large apparatus, carried to so commanding a height, I was able to take a number of instructive telephotographic views.

The most considerable affluent, which the main glacier receives from the south debouches from a magnificent valley of about half a mile broad, exactly at the point, where the axis of the main glacier bends farthest to the south. Hence this lateral valley penetrates the most deeply into the mountain chain towering up on the south. Pushing forward into this valley, the bordering ranges of which are extremely grand—not a spot of bare rock to be seen on their slopes—and reaching a gap some 15,000 ft. (4,600 m.) high in the ice-wall of its western rim, I was able to inform myself respecting the course of the great lateral ice-valleys, which branch off from the lower part of the main glacier, and, bending with a sharp curve from south to east, thus interpose between the Semenoff and Mushketoff glaciers. From these, and other forays in all directions along and across the ice of the Semenoff glacier, I was able to collect a store of important information, concerning this central nevé-basin and its connection with the surrounding valleys. But for all that, I had not yet got a reliable answer to the question, out of which valley rises the terminal cone of Khan-Tengri?

Having completed his survey of the Semenoff

Digitized by Google

glacier, Herr Keidel, on August 7th, started on his homeward journey. His military duty called him back to the fatherland.

I continued my exploratory journey alone, and betook myself to the Adyr-tyr valley. The next task devolving on me was to make a complete circuit of the Mushketoff glacier, to make a survey of it, and to determine its connection with the Semenoff glacier. This was accomplished in the course of a week. And included in this task was the ascent of a peak 15,400 ft. high (4,700 m.), on the north edge of the glacier, from the summit of which a panoramic view was taken of the magnificent southern wall of the glacier.

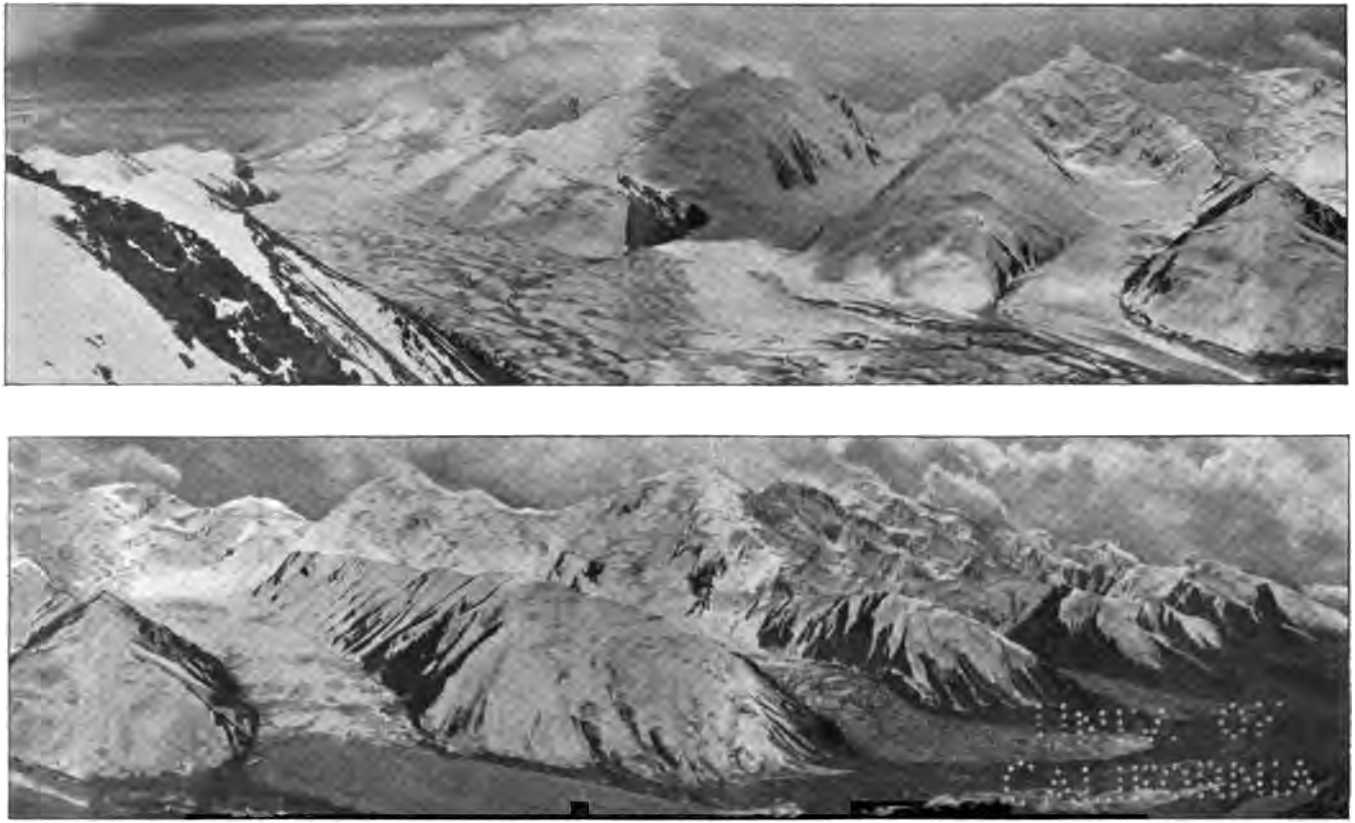
Of the Mushketoff glacier I can here only hurriedly cite a few elementary features. From its tongue, which ends at about 11,400 ft. (3,480 m.)—that is, some 390 ft. (120 m.) lower than that of the Semenoff glacier—up to its origin in the nevé-basin of the Semenoff glacier, the Mushketoff glacier has, according to my determinations, a length of approximately thirteen miles (twenty versts). It is, therefore, much longer than Ignatieff estimated it—namely, five miles (eight versts). The lower part of the glacier is so thickly covered with débris masses, that hardly a bit of ice crops through them. Only three to four miles farther up does the ice become free; its surface is there very humpy, and torn in a most extraordinary manner, whilst it is also bare of snow. In its last third, however, the ice becomes fairly well closed, and bears a slight snow-mantle. The total

Digitized by Google

fall of the glacier is indeed slight, but nevertheless greater than that of the Semenoff glacier. As in the case of the latter, its main stream does not issue from the end of its snout. The slope of the surface of the glacier towards the northern bank, the cause of which I have previously referred to (*vide* p. 47), causes its main efflux to issue from the precipitous north slope of the tongue. Between this and the mountain wall at the side there runs a deep trench, through part of which the glacier-stream runs with rapid current. The slopes are there almost free from snow, but wholly covered with débris and blocks of rock. At their base there stretches, for at least eight miles (twelve versts) into the region of ice, an irregular, often interrupted girdle of grass banks with a fine Alpine flora. The whole of this northern wall, broken by no valley indentation, bears only on its highest ridge and on the peaks the ornament of firn and ice. On the other hand, the wall bounding the glacier on the south side and separating it from the Inylchek glacier, presents quite a wonderful chain of ice-peaks, far surpassing in height and wealth of form the engirdling southern wall of the Semenoff glacier. Its snowy mantle is rarely pierced by a particle of rock.

Several of these peaks count among the most magnificent and highest of the Central Tian-Shan. Their height was determined both from Pfann's and from Keidel's basis. Out of high valleys between the single peaks descend exceedingly steep and much-crevassed glaciers, which debouche

Digitized by Google



CHAIN BORDERING MUSHKETOFF GLACIER ON ITS SOUTH, TAKEN FROM A POINT (ABOUT 14,500 FT.) ON THE NORTH.

[*To face p.* 190.

Digitized by Google

Digitized by Google

with beautifully curved terminal tongues into the main glacier. They affect the ice-covering of the main glacier in a curious way, producing great irregularity and ruggedness on its surface. In the middle part of the glacier are fifteen to twenty ice-lakes of various sizes, green in colour and quite irregularly distributed. Throughout the half of its lower course, the glacier has an average breadth of fully three-fifths of a mile (one verst). It then gradually widens till, in its last third, it attains a width of two to two and a quarter miles (three to three and a half versts). There it is separated from the Semenoff glacier—*i.e.* its lateral valleys—only by that low, broad wall, previously spoken of (*vide* p. 56 *et seq.*), crowned by blunt, snow-capped domes and traversed by the Mushketoff pass (14,400 ft.; 4,400 m.). This wall runs gradually out into the *nevé-basin common to the two great glaciers, a basin in no respect connected with Khan-Tengri, and to this fact all hitherto existing assumptions have to be adjusted.* Gigantic mountain-walls interpose between it and Khan-Tengri, a fact already disclosed by the results of the previous year's investigations.

The rocks constituting the environing walls are the same as in the case of the Semenoff glacier: an irregular series of dark argillaceous slates, phyllitic slates, and dark and pale limestones, filled with fossils, which on account of severe pressure are no longer identifiable, alternating with gneiss, granite, dark argillaceous slates of different character, and light striped marbles. There is frequent

Digitized by Google

alternation, but unfortunately the stratigraphic relations are not determinable. Just as on the southern wall of the Semenoff glacier the whole series lies completely buried under firn and ice, also here; on the northern wall, where snow and ice recede, the series is everywhere covered with a chaos of shingle and débris.

In this valley, too, from which I had the privilege of beholding the pyramidal peak of Khan-Tengri grandly displayed, I obtained no full assurance as to its situation. I was, however, more than ever confirmed in the assumption that its basis must be found in the Inylchek valley. Of all the great glaciers of the Central Tian-Shan that I have visited, the Mushketoff glacier is the only one, which shows unmistakable signs of recent retreat.

Digitized by Google

CHAPTER XVII

SECOND VISIT TO THE INYLCHEK GLACIER, AND DISCOVERY OF THE TRUE POSITION OF KHAN-TENGRI

OUR next goal was the Inylchek valley. Being this time aware of its inhospitable nature, and thus prepared for all contingencies, and furthermore provided with the indispensable number of stout porters, I hoped our operations would prove more fruitful this year than the last. On this depended our chance of getting to the very base of Khan-Tengri.

As already stated (*vide* p. 76), I had, the previous year, when I visited the high plateau between Tys-ashu and Sary-jass in company with Herr Pfann, seen from thence the final cone of Khan-Tengri raised far higher out of its surroundings, than from any other point, even at a greater altitude. As I hoped, somewhere in the region of that plateau, to find some still more favourable spot for an examination of the ranges grouped round Khan-Tengri, I sent the caravan by the valley route to the Tys-ashu valley, while I with a small party turned westwards. Ascending the low-browed ridge, forming the margin of the Adyr-tyr middle course, and crossing its crowning plateau, I

Digitized by Google

traversed the upper Jam-tama valley and its western border, and thus reached the deeply eroded valleys of the head waters of the Kusgun-ya (*vide* p. 62). Neither these nor the previously-mentioned valley are shown on the maps, as I pointed out when describing the Tys-ashu valley. They have their sources in the south-east and south-south-east, in the broad, shallow, lofty nevé-basins, stretching between the southern border of the Mushketoff glacier and the northern chain of the Inylchek valley, and debouche northwards in the Sary-jass. At the head of the Kusgun-ya valley I mounted a high dome (about 12,300 ft.; 3,750 m.), and beheld due east of me the pyramidal summit of Khan-Tengri, towering high above the surrounding ranges. Here I commanded a full view of the black belt, which at the foot of the summit proper encircles the west and north-west flanks of the mountain, and which I had already partly seen from other points. Close to it was also visible a broad black ridge, both belt and ridge contrasting sharply with the light-coloured pyramidal summit. Not till later was I able to determine the true character of this interstratified black formation.

North-east of Khan-Tengri I noticed, for the first time, a sharp snowy peak, which was evidently higher even than the giants, rising in the angle between the Bayumkol and Semenoff glaciers. This summit seemed to shoot up out of a range, radiating in an east-north-easterly direction from Khan-Tengri. Hence, I had to assume that, be-

Digitized by Google

tween this range and another, running parallel with it, a valley intervened, which, leading from the foot of Khan-Tengri, followed the direction of that range—that is, to the east or south-east. In this case the snowfields of the culminating summit might possibly not drain at all to the west, so that perhaps it would be useless to try to approach the summit from this direction. But in case some valley really did drain those vast fields of nevé in an easterly direction, which of the streams, seen in all my wanderings, was copious enough to be its outlet and where does it debouche? In the northern, or more probably in the southern, Musart valley? I surely must have noticed such a voluminous affluent, did it enter either of those valleys. But if, after all, there exists drainage from Khan-Tengri to the west, does it flow through the channel of the Inylchek, or through that of the large parallel Kayndy valley, stretching still more to the south? These were the problems which pressed upon me. Doubtless, from all sides one may see the gigantic final pyramid of the culminating summit of the Tian-Shan system. It is seen towering some 3,300 ft. (1,000 m.) above all the surrounding ranges, although, owing to the defective character of all extant maps, one is unable to say from which of the many diverging valleys it shoots upwards. Thus my second summer in the Tian-Shan was drawing to a close, while the main problem was still shrouded in mystery. On the possibility of ascending the

Digitized by Google

Inylchek glacier to its source, might depend the solution of the puzzle.

After taking a telephotographic view of the giant peak and of the chains encircling it, I descended into the western branch of the Kusgun-ya valley, and ascended nearly to the same height on the Tur plateau, where I made additional surveys, and then hastened down to the Tys-ashu valley, where I again joined the caravan.

In the Kusgun-ya valley I was able to determine the intrusion of diabasic rocks, which had calcined red and fritted the environing limestones, exactly as I had noticed the previous year in the neighbourhood of the Tys-ashu pass (*vide* p. 65).

The caravan crossed this pass, which I now also preferred as the shortest way to the Inylchek valley, though not without serious difficulties. It was alone due to the heroic co-operation of all my people that no serious mishap occurred on the glacier of the pass, which was in a very bad condition. On the south side, while still high up the pass, we were detained two days by snow-storms before it was possible to make our way down to the valley. Two miles (three versts) below the tongue of the glacier ice I established our headquarters, this time on the right bank.

The difficult task of traversing the huge glacier was at once taken in hand. I first of all set up a store of provisions about six and a half miles (ten versts) up the glacier, and then moved up the encampment from post to post. Owing to the great obstacles, presented by the mountains of boulder

Digitized by Google

drift encumbering the surface of the ice, as already described, we made but slow progress on the lower course of the huge ice-stream. To understand what follows, I must here return, however briefly, to the observations made the previous year: After covering about two miles (three versts) on the glacier, one sees rising, far ahead, out of the ice-field, a high, dark, and massive buttress, which divides the glacier into two branches, a narrower northern one, and a much broader southern one. It was soon seen, that this rocky buttress could not be merely the wall of some isolated eminence rising out of the glacier, since its brow was surmounted by snowy crests, rising behind it. Hence the black buttress was evidently the abrupt escarpment of a mountain range, branching off somewhere from the confining ranges of the Inylchek glacier valley, and projecting south-westwards into the broad ice-field. Advancing about 500 yds. (half a verst) farther, and looking up the slope of the glacier, we perceived the pyramidal top of Khan-Tengri to the left of, but far beyond, the dark escarpment, without being able to ascertain with certainty how far beyond, or to say from what range it springs. A few hundred steps farther, and the interesting picture has again vanished. Still, it seemed highly probable that, if we succeeded in penetrating into the northern branch of the glacier valley, we should necessarily get near to the basis of the pyramid, whether it rose there at the head of the valley, on the watershed, or in some intersecting side-valley. On

Digitized by Google

this I based my plan, and felt confident that it must succeed, if only the weather proved propitious.

At that time I was not yet aware that Khan-Tengri could also be sighted farther out, in the upper middle course of the Inylchek valley. Nor would the fact have helped, since, owing to the peculiar shifting of the bounding ranges, the view from that quarter would afford no certain clue to the real position of the mountain.

I next shifted the camp on to the (orographical) left margin of the glacier, so far up (about ten and a half miles from its lower end) that we found ourselves just opposite the southern termination of the intervening range. Here I could satisfy myself for the first time of the important fact, that this was a very considerable mountain *massif*, a quite compact spur, which must evidently branch off from the ridge forming the head of the valley—that is, from the main water-dividing range trending eastwards. Out of the plateau-shaped crest of the imposing intervening range, one could now see cropping up some rugged, lofty, and snowy summits; but here nothing more was to be seen of Khan-Tengri.

The material of which this great intervening range is built up, is the same as that of the main chains flanking the glacier. First of all, a narrow belt of phyllitic and sericitic schists of varied character; then dark and coloured clay-schists, diversely metamorphosed, extremely pressed and crushed out; then light and dark limestones; further on

Digitized by Google

LAKE KARA-KUL-SAY--ABOUT 11,150 FT. (SEE P. 260).

PARTING OF INYLCHEK GLACIER.

[*To face p.* 198.

Digitized by Google

UNIV. OF CALIFORNIA

Digitized by Google

lamellated, sandy-clay strata, whose nature and colour are constantly changing; again, dark limestones, and lastly white and striped marble. With all its clearness of arrangement as a whole, this vast stratified system shows in places the greatest irregularity, disorder, and tremendous disturbance. Old crystalline rocks are to be seen neither in the central *massif* nor in the border-ranges. The limestones have been greatly metamorphosed and in several beds occur very numerous organic remains, changed to silicates, but nothing that can be clearly identified. At the mouths, however, of some lateral valleys I was able to detect some lower carboniferous fossils in the fragments of limestone drift brought down by the ice.

Where it is not yet divided by the middle range, the glacial valley has a breadth of from two and a half to three miles, and farther on, where it is no longer covered with boulder drift, it is traversed lengthwise by five parallel moraines. Even in these no fragments of primitive rocks are to be seen. All the more surprising is the occurrence of an exceptionally huge granite moraine on the left margin, which was followed by our ascent. This moraine girdle consists exclusively of blocks of light-coloured granite of varied structure, and pegmatite, often of quite colossal dimensions. Almost from the tongue-end of the glacier up to this point—that is, at least ten miles (fifteen versts)—it formed the left margin of the glacier, and of all the morainic beds of the main glacier is by far the largest. Whence

Digitized by Google

came all these masses of granite drift, since here in the valley no granite occurs anywhere?

From the camp on the left edge of the glacier, where the slopes of the old bank-moraines, facing northwards still bear a thick carpet of herbage in spite of their position so far within the realm of ice, an attempt was now made to penetrate up the northern branch of the glacier. Where the middle range divides the enormous ice-field it is very uneven, and unusually crevassed, owing to compression against the cliffs. The crossing was difficult, and when at last we approached the entrance of the northern glacial valley, we found ourselves suddenly confronted by a wide depression, which had hitherto been hidden by the ridges and furrows of the glacier's broad back. It stood at a level of about 11,800 ft. (3,600 m.), and was filled with an icy lake, in whose blue waters floated thousands of tiny icebergs and frozen blocks in every shape and form—altogether a magnificent sight.

The lake extends for three-quarters of a mile across to the opposite bank, where the splendid picture ends in a very high and picturesque, bold peak, which springs from the dividing ridge between the Mushketoff and Inylchek glaciers. My admiration, however, soon yielded to a feeling of disappointment. The lake was found to be enclosed on both sides by precipitous rocky walls, about 3,900 ft. (1,200 m.) high, which descend close to the water's edge. Attempts were made both on the north and south side to

Digitized by Google

clamber round these walls, and thus to turn the lake, but all in vain. The lake stretches for about two and a half miles (four versts) into the northern branch of the glacier, which here averages three-quarters of a mile in breadth, and would probably have offered no further obstacles to the passage over its surface. Owing to the northerly bend of the southern flank of the valley, here, too, no view could be had of Khan-Tengri. But the dazzling white Semenoff peak could be seen, rising quite in the background of the long ice-valley or even still farther back. As we had hitherto always seen Khan-Tengri to the south-west of this peak, there could no longer be any doubt, that the base of Khan-Tengri must be reached through this glacier valley. Thus, the goal which I had so long yearned for and struggled to gain seemed now near at hand, yet could not be reached. At this I was naturally much disheartened.

The only possibility of penetrating into the valley was by crossing the range on the southern side—that is, the middle range. For this two days would be required, and so difficult an undertaking could never be carried out with heavily laden porters. But without a supply of provisions and the most indispensable camp requisites, it was not advisable to penetrate into a glacier valley, which apparently extended at least thirty versts farther to the north-east. The additional supplies would also have to be forwarded by the same difficult route, since under

Digitized by Google

the most favourable circumstances we could not get back under six days. Hence the attempt had to be given up, and with it my project seemed to be once more defeated, as in the previous year. But it was now made quite clear that the mystery of Khan-Tengri would really have been solved on that occasion in the previous year, had not the ascent of the snowy peak on the southern border of the Mushketoff glacier been thwarted by the avalanche when within a few feet of the summit (*vide* p. 57). But, despite all adverse circumstances, I was determined not to give the matter up.

In order to settle the question, as to whether the base of the monarch of the Tian-Shan might not also be reached from the southern branch of the Inylchek glacier, we ascended a peak on its left bank from 16,400 to 18,000 ft. (5,000—5,500 m.) high as far as its shoulder, a sort of platform about 14,700 ft. (4,500 m.) high. This projecting ledge presented an excellent standpoint for overlooking and taking telephotographic and ordinary views of all the enclosing ranges of the vast glacial basin, with the middle range, the icy lake, etc. I must here point out, that the chain, skirting the Mushketoff glacier on its south side—that is, the chain on the north side of the Inylchek glacier—also presents on its southern slopes the aspect of an almost uninterrupted mantle of ice and snow, not indeed, from crest to base, as on its northern slope, but at any rate down to half its height, and, seen even from this position, it produces a profound impression from

Digitized by Google

the grandeur of its mountain forms. Especially valuable to me was the discovery that, far beyond the point at which the glacier again describes a sharp bend to the north-east, there rose the upper portion of a snowy pyramid, which, from its form and aspect, could only be the summit of Khan-Tengri, and consequently, that its base must also be reached through the southern glacier valley. Moreover, from the trend of the moraines, traversing the broad ice-fields in curved lines, it could be quite clearly perceived, that archaean rocks do not enter into the structure of the culminating peak, nor of the most elevated section of the Tian-Shan at all. The light-coloured granite moraine, sharply distinguished from the neighbouring dark moraines, could now be followed only for some eight miles (twelve versts) farther up the left margin of the glacier, where it abruptly terminates at the mouth of a lateral valley. Hence the granite masses could only have been derived from this lateral valley.

The essential point now was to push forward, in order accurately to corroborate all these new facts by completely surveying the further course of the glacier, the extent of which so greatly exceeded all previous assumptions. My supplies were, however, limited, the distance from head-quarters considerable, communication difficult, the weather unsettled and doubtful. Hence the work had to be done rapidly if at all. With a tremendous effort the camp was moved some thirteen miles (twenty versts) farther up the

Digitized by Google

glacier, where I was able to grant a respite to the almost exhausted porters, with the intention of then pushing on alone with the two Tyrolese.

On the way up from the forking of the valley we soon reached a portion of the glacier unencumbered with drift, showing only at unequal intervals the dark lines of the three medial and two lateral moraines. In each of these moraines different materials prevail. As already stated, the light-coloured granitic moraine on the left margin accompanied our route only for about eight miles (twelve versts) more. Here the mountain rampart is pierced by a glacial valley about three-quarters of a mile (one verst) broad, with a perfectly level surface (height at confluence about 12,600 ft.; 3,850 m.). Very imposing are the icy walls enclosing this valley, but not an inch of bare rock is to be seen, to account for the mass of granite débris in the moraine. But at its head the walls fall away suddenly, and just beyond there seems to be a large, longitudinal valley, running parallel, with the Inylchek. From the information here obtained I could at that time only take it for the Kayndy valley. Yet it seemed strange and hard to explain, that, immediately to the west of the granite-bearing side-valley, and branching south-westwards towards the parallel valley, a ridge crowned by a large snowy plateau should be seen projecting from the dividing range between the two main valleys out into the glacier of the next parallel valley. My standpoint was too low, to allow me to follow the course of this

Digitized by Google

ridge for more than a short distance. Hence I did not realise the part played by it until I visited the Kayndy valley. As the huge masses of granitic deposits—in the main valley alone the moraine has already a length of about seventeen miles (twenty-six versts)—come exclusively from this lateral valley, I necessarily inferred the existence of a large granite *massif* in the parallel valley. In the immediately following moraine light grey limestones prevail; in the next, dark schists, intermingled with marble; in the fourth, marble almost exclusively, in blocks sometimes of huge size; lastly, in the right lateral moraine, dark eruptive rocks, about which I shall have more to say presently. From the distribution of the rocky elements it was to be inferred that each of these moraines had its source in a mountain recess, where a distinct formation prevailed.

The chief glacier, which so far had already a breadth of over two miles (three versts), expands here to about four versts. The chain on the right margin—that is, the middle range dividing the valley—is intersected by no transverse valleys, and furrowed only by gullies high up. On the other hand, in the range on the left bank, valley succeeds to valley, each enclosing magnificent, extensive glaciers. By the pressure of these lateral glaciers, the ice of the chief glacier has here been pent up and tossed into chaotic crevasses. We were thus driven to the right side, where crevasses were certainly not lacking, but where they could be turned. Here the ice was disposed in hillocks,

Digitized by Google

chiefly through irregular thawing, due to the unequal distribution of the overlying detritus, and partly through the erosion of water-currents.

In the range on the right side, there now appear extended walls of almost black eruptive matter, standing out sharply in a long series from the light-coloured schists and marble declivities. These are interstratified masses of highly metamorphic rock, which are doubtless well developed also on the southern margin, as I was able actually to notice in a few places. But on that side most of the formations are hidden beneath the almost unbroken snow and ice mantle of the slopes, there facing northwards. It is scarcely possible to form an adequate idea of the endlessly varied outlines and grandeur of the crests, which rise above this almost uninterrupted glacial rampart. It is of very considerable breadth, and divided into several ridges by trough-shaped high valleys.

To judge from the altitude of the very numerous glacier tables, consisting mostly of large marble slabs, the whole thickness of ice, melted during the summer, was no more than three to five feet—a quantity easily replaced by the winter, which lasts from seven to eight months in this region. The shortness of the summer season, lasting at most three months, the enormous extent of the glacier, its slight incline (only 140 ft. per mile), the immense accumulation of snow on the border-ranges, encircling the upper glacial basin, and, lastly, the thick covering of detritus on

Digitized by Google

its lower course, explain the stability of this ice-stream.

Whether I should reach Khan-Tengri now depended on the projected advance, which I had determined to make with the two Tyrolese from the last elevated encampment. Only a few miles higher up we entered upon an unbroken icefield, with a very gentle incline, and covered with an almost firm and nearly level coating of snow. These conditions enabled us to push very rapidly forward on the glacier—here about two miles (three versts) broad, and penetrating deeply into the heart of the frozen mountains. As far as the eye could reach all was dazzling white; from the wall on the right margin alone there projected sharply a dark, rocky bluff, standing out boldly in the almost arctic landscape, and concealing what lay beyond. Should we there find the long sought for Khan-Tengri? The range on the left side, too, assumes, northwards of the wide granite-bearing lateral valley, more and more the form of a *massif*, to which a series of high-lying corries and valleys gives a remarkably diversified configuration. Extraordinary masses of nevé are here stored up, while picturesque glaciers descend thence to the valley. The entirely glaciated range, which apparently closes the head of the valley, branches into two spurs, which at first run parallel, but one of which soon turns east, the other east-south-east. Thus here, too, as so often elsewhere, we have a two-fold conformation.

We had now been traversing the icefield for

Digitized by Google

nearly five hours at high speed; the enclosing escarpments began to fall away; the lateral glacial valleys grew shorter, broader, mostly rounded off at their heads, and still the dark bluff mysteriously concealed the riddle of Khan-Tengri from our prying eyes. Then, suddenly, something white began to assume prominence behind the black edge of the promontory—nothing yet very conspicuous, but with every step forward the white object grew bigger and bigger. A fine snowy summit, glittering in the sun, appeared aloft, colossal white marble buttresses projecting from it; a few steps farther, and a huge pyramid stood out freely, its base also soon coming into view. The giant mountain, the monarch of the Tian-Shan, revealed himself to my enraptured gaze in all his naked majesty, from his feet, rooted in the glacier ice, up to his crown, wrapt in sunlit shifting mists. Nothing whatever intervened to conceal any part of the so long mysteriously masked base of the mountain. I found myself standing close to its southern foot, and contemplated in wonder, with amazed and searching glance, the sublime spectacle. The strain of the last few weeks, which had at last grown almost unbearable, was relieved in an instant; the goal had been reached, which I had eagerly struggled for with all the strength of mind and will. My feelings at that moment baffled all description.

I know of no other great mountain that is so completely cast in a single unbroken mould, so evenly scarped, without shoulder or *arête* from its

Digitized by Google

topmost crest down to the valley. Yet I should like at once to point out that, however powerful the impression it produced, still, it did not correspond to what might be expected from the solitary grandeur of Khan-Tengri, which so greatly overtops all other surrounding peaks. I stood too near its base, and at too low a level, to see its outlines in proper perspective and without too much foreshortening. The altitude reached by me on the glacier was about 14,800 or 15,000 ft. (4,500 or 4,600 m.); and if the summit of Khan-Tengri attains 23,600 ft. (7,200 m.), the difference of 8,500—8,800 ft. (2,600—2,700 m.) was compressed into far too narrow an optic angle. Naturally, this effect must be still more marked in the photographs taken by me at this spot. In order to do full justice to the majestic form of the monarch of the Tian-Shan, and render it in the picture, an elevated point would have to be scaled in the range bounding the glacier on the south, opposite the mountain, at a distance of about two and a half versts. For this, however, there would be needed long preparatory work and especially settled weather; but this had already been for some time unsettled, with snowstorms every afternoon, and another was just then evidently approaching.

It was now quite clear, that the culminating eminence of the whole Tian-Shan does not stand in the main watershed, and is not a nucleus of converging ranges, so that all preconceived notions of the part played by it in the Tian-Shan system must be given

Digitized by Google

up. The pyramidal summit rises, in fact, out of the secondary spur, which projects from the main range far to the south-west, and divides the Inylchek glacier valley into two sections. Between this secondary spur and the part of the main range which had hitherto appeared to close in the head of the valley, the southern main glacier is prolonged for a much greater distance than could be supposed, running north-eastwards through a somewhat winding valley, which, from this point, narrows considerably and at the same time becomes steeper. I was unable to see up to the head of this valley. To do so I should have had to advance at least four miles (six versts) farther up the main glacier, for which there was no time, while the attempt was prevented by the state of the weather, visibly growing more threatening. Up to the foot of Khan-Tengri I had covered thirty-five miles (fifty-three versts) on the glacier, and, as already stated, the distance as far as the entrance to the glacier-valley, now narrowing away to the north-east, was about four miles (six versts). According to my estimate, based on the trend of the crests, this uppermost glacial valley must extend at least from four to five miles (six to eight versts) farther to the north-east. *Hence the Inylchek glacier must have a total length of from forty-three to forty-six miles* (*sixty-five to seventy versts*), *as compared with the hitherto-given estimate of from six and a half to eight miles* (*ten to twelve versts*). *It accordingly ranks with the very largest ice-streams of the mainland.* I have every

Digitized by Google

reason to assume, that the junction of the lateral mountain branch, bearing Khan-Tengri, with the main range takes place at or near the so-called "Marble Wall," in the Bayumkol valley—the very spot which figures on all maps as Khan-Tengri itself. *Hence, not Khan-Tengri, but the "Marble Wall," is the true nucleus, the "knot" of the main ramifications of the Central Tian-Shan system.* As it had now to be named, I could find no name more suitable to its importance, than that of the first President of the Imperial Russian Geographical Society, His Imperial Highness Grand Duke Nicholas Mikhailovich, who takes such a lively interest in the exploration of the Tian-Shan. I accordingly propose to call this central summit Mount Nicholas Mikhailovich.

As was already to be inferred from the preceding observations, we must now give up *the hitherto current view, that primitive rocks enter into the structure of Khan-Tengri, and all the inferences associated with this view must similarly fall to the ground.*

The most elevated and central region of the Tian-Shan is built up exclusively of sedimentary rocks, as has already been shown by my previous observations, and was confirmed by all my subsequent researches. The pyramidal cone of Khan-Tengri consists of more or less metamorphic limestones, and of stratified marbles. In the structure of its base the same limestones are associated with diversely metamorphosed and even crystallised schists. In this series of formations are interstratified huge

Digitized by Google

masses of dark, metamorphic rocks, apparently of diabasic character, constituting the black belt (*vide* p. 194), which encircles the pyramid, and which had already been noticed by some travellers from a distance. Of the same rocks is formed the broad dark ridge, which is seen close by, especially on the west side. How powerfully the transforming forces have co-operated with the contact of the eruptive rocks is seen in the fact, that in their neighbourhood, the limestones and schists have been calcined and fritted a deep red. Fossils, collected by me in the limestones of the lower part of the glacier valley, may perhaps justify an inference, concerning the age of all these deposits.

Now, if Khan-Tengri does not owe its origin to any of the eruptive (primitive) rocks, how are we to explain its peculiar isolated position, the mystery of its solitary eminence, towering still some 2,600—3,280 ft. (800—1,000 m.) above all the neighbouring summits? It may be noticed even from the middle course of the Inylchek valley that, despite all local disturbances, the general stratigraphic structure of the ranges shows on the whole a southern dip on the southern rampart; and the stratified beds on the northern rampart, on the contrary, show in general a northern dip, apart of course from greater or less deviations to the east and west. This may be observed even along the flanks of the middle range, dividing the Inylchek glacier valley, and in the very structure of Khan-Tengri itself. *Here, then, we seem to have the core of a formerly existing colossal*

Digitized by Google

anticlinal, which, owing to subsidence and faults along the periphery, was ruptured and collapsed. In this report frequent mention has been made of extensive areas of subsidence and faults in the highlands north of the Inylchek valley, and such were subsequently observed in the south also. *Of the crown of the old arch nothing has been preserved, save the summit of Khan-Tengri. Thus and thus alone can its isolated eminence in the vast Tian-Shan system be explained,* an eminence which, apart from igneous cones, is without example in mountain systems of like extent. I am sorry I must here refrain from entering more fully into this subject, which will be dealt with in the more detailed report.

Facing my standpoint at the foot of Khan-Tengri there opens in the southern rampart a glacier valley, which averages about one verst broad, slopes gently upwards, and at its head shows only a broad, flat sill. It must give easy access to the immediately following *large parallel, longitudinal valley, which doubtless conceals a glacier rivalling the Inylchek, but of which hitherto nobody had any knowledge.* Had we been provided with the needful supplies, fuel, and the requisite number of porters, we might have started from this point on the exploration of this large unknown glacier, and at the same time followed the course of the Inylchek glacier to its very head, and explored more carefully its enclosing ramparts. But when it is remembered that the distance from our base at Narynkol was about 180 miles, by a route in

Digitized by Google

places very difficult, and that most of what was required for a party, numbering at least ten, and for a stay of several weeks in this icy region, would have to be brought thence, it will be understood that such an undertaking exceeded the resources of a private explorer. It would, in the first place, have been quite impossible for him, in a country like this, to hire the additional number of trustworthy, experienced and disciplined porters, indispensable for the purpose, and whose number I estimate at from twenty to twenty-five. But not more than at most ten really capable and good climbing porters could anywhere be obtained; even these would be found wanting at critical moments, as had so often happened to me, and the expedition would then fail in its object. An expedition, organised by the Imperial Russian Geographical Society, and backed up by the Government, could alone carry out such an undertaking with success. As I hoped in any case to be able, during the further course of the journey, to penetrate from some point of its middle course into that large, parallel, longitudinal valley, I did not regret the opportunity now postponed. As it turned out, however, this unknown glacial region was fated to remain closed for me also.

I should like here to make a few brief remarks on the possibility of climbing Khan-Tengri, as it has been wrongly assumed, that this exploit was the main object of my expedition. The heavily glaciated plateau, crowning the ridge out of which rises up the huge pyramid, I estimate at about

Digitized by Google

1,800 or 1,600 ft. (400 or 500 m.) above my standpoint on the glacier. At the west base of the pyramid a saddle filled with nevé is sunk deep in the back of the plateau-like ridge; from this a steep but still passable glacier *couloir* descends to the main glacier. Hence the saddle can be reached without any great difficulty, and from it the pyramid may still rise to a height of about 6,900 ft. (2,100 m.). The southern *arête* and the south face are unassailable, the very thought of attacking them being excluded by their tremendously steep glaciated slope. A little more hope is awakened by the rocky and much curved south-west *arête.* If the angle of inclination of the pyramid's south-west *arête* be put only at forty-five degrees, a very moderate estimation, the absolute height of the culminating point above the saddle at 6,900 ft. (2,100 m.), and the windings of the ridge be taken into consideration, there would be rather more than 9,900 ft. (3,000 m.) of a rock *arête* to be surmounted. Since, as already stated, the pyramid consists of marble, which, as is well known, is the kind of rock that presents the greatest difficulty to climbers, while in places the strata are disposed one above the other like tiles on a roof, the experienced Alpinist will be able for himself to form some idea of the difficulties awaiting him. Nor are there any chimneys, by which the ascent might be facilitated. Ledges and terraces, as far as can be judged from below, are hardly discoverable, except a little beneath the summit, while, on the other hand, there is

Digitized by Google

no lack of all kinds of obstacles along the *arête*. Yet this side offers a better promise of reaching the top, than any other direction.

A traveller, who a few years ago observed Khan-Tengri from the Sary-jass valley, and perhaps also from a somewhat nearer standpoint, considered, apart from the great mistake he made regarding the direction, from which the mountain should be approached, that the north-north-east slope, with its great chimney, was of relatively easy ascent. This, however, is not the case. On several occasions we had sufficiently close views of that wall, and all the members of the expedition were unanimously of opinion, that it offered not the slightest chance of a successful ascent.

A *sine qua non* for every attempt is, naturally, the possibility of bringing thither everything needed for several weeks' stay in that glacial region so difficult of access. What this means has already been pointed out. Lastly, the very precarious climatic conditions have to be considered. If icy winds blew daily down the valley, as they did during my sojourn on the glacier, the mere attempt to climb the rocks of Khan-Tengri would be out of the question. By increasing atmospheric disturbances, followed by a snowstorm, a premature end was put to my observations at the foot of Khan-Tengri, when we had scarcely been able to take the most indispensable photographic views.

Digitized by Google

CHAPTER XVIII

OVER THE ACHAILO PASS TO THE KAYNDY GLACIER

FROM our chief encampment at the end of the glacier-tongue I made my way a few days later some eighteen versts down the valley, where remains of old morainic drift could constantly be observed, often reaching more than 1,000 ft. (300 m.) high up the walls of the valley. Shortly before reaching the old barrier (see p. 68) the wild Achailo torrent debouches on the left bank from a narrow, rocky gorge (confluence about 8,600 ft.; 2,800 m.). It is noteworthy, that this lateral stream is the only one in the middle and lower course of the Inylchek river, that discharges at the level of the main valley-bed. All other lateral valleys have their mouths very high above the level of the main valley. The deep erosion is here explained by the copious stream, the steep fall compared with its short course, and by the very disturbed and decomposed schists, in which the valley is cut. Of the two branches of the head waters, one comes from the east, the other from the south-east. Both drain considerable glaciers, which descend from an hitherto unknown range, sumptuously clothed with glaciers, which extends, in a direction north-west to south-east,

Digitized by Google

for about eighteen versts between the Inylchek and Kayndy valleys, and presents a great variety of forms.

This superb mountain range rises on an average to a height of about 13,000 ft. (4,500 m.), while its highest peaks exceed 16,000 ft. (5,000 m.) Between it and a parallel limestone range, whose northern part presents a typical instance of a ridge in a state of almost accomplished abrasion, there intervenes a shallow trough, a kind of a high plateau (Syrt), which has an average breadth of three versts, having a mean height of about 12,000 ft. (3,600 m.), and is richly carpeted with Alpine herbage. On its scarcely distinguishable highest protuberance (about 12,500 ft.; 3,800 m.) lies the watershed between the Inylchek and the next parallel valley, the Kayndy.

As already stated, none of the maps show any of the valleys and mountain ranges, amid which my expedition now moved for ten days or more. As my surveys have not yet been worked up, I shall for the present confine myself to emphasising the more salient features. The above-mentioned plateau (Syrt) is nothing more than the floor of an old glacial trough, from which formerly large glaciers, about 2,500 or 3,000 ft. (800 or 900 m.) deep, descended on both sides, one very steeply down to the Inylchek, the other more gently to the Kayndy valley. This can still be clearly traced on both sides, but especially on the Inylchek side, by the course followed by the old moraines. Rocks entering into the

Digitized by Google

structure of this lofty range, and extending farther on to the Kayndy valley, are highly metamorphised schists of very diversified appearances—phyllites, semi-crystallised limestones, white marble, and lastly, diabase. The schists and the limestones are set at a high angle. In the first lateral valley, descending from the east, appear to lie the largest glaciers and to rise the highest snowy peaks, as may be seen in the ascent from the north. They assume their grandest forms in the vicinity of the pass, where at the foot of a beautiful, bold peak, a morainic lake of considerable size extends into the green Alpine meadows. On the descent down the south side are seen huge "Tors" of diabase, which break through the rugged masses of the limestones and schists, and often develop wild jagged crests along the highest ridges. In none of the Central Tian-Shan valleys, save in the immediate neighbourhood of Khan-Tengri, have I seen igneous rocks of such extent and thickness, as those along the upper course of the Kayndy. Here the eruptive matter (diabase), displays very diversified character.

Near its junction with the Kayndy the trough-shaped valley running southwards from the plateau contracts to an impassable serrated cañon, confined between vertical limestone walls. The track therefore leads up very steep slopes on the right bank to a considerable elevation, where the whole surface is strewn with great quantities of white marble and contact-schistose blocks. The descent is quite as steep to the Kayndy valley, which owes

Digitized by Google

its name to the birch-woods, characteristic of its lower course. In its upper course, which has a breadth of from a quarter to half a mile, the mounds of débris, lying at the foot of the almost vertical limestone walls on the left bank, are overgrown with little clumps of pine.

As the axis of the valley frequently follows the strike of the strata (N. by 40° E.) the side facing the dip of the strata has a steep, sometimes perpendicular front. Nevertheless, the escarpments of the valley do not present the same imposing character as those of the Inylchek valley. The ranges are not so high, and present less diversified outlines.

From the mouth of the southern Achailo river we wandered along the left bank of the Kayndy, over a broad, very gently-inclined, grassy terrace, some sixteen miles up to the tongue of the glacier, which stands at a height of about 11,500 ft. (3,250 m.). I was surprised to find no trace of granite or of other archæan rocks along the whole way, either in the river drift or in the morainic beds. From this it may be inferred that the often-mentioned granite *massif*, whose fragments are brought down and deposited on the Inylchek glacier, was not in this valley, as I had hitherto supposed. The river consists of a single channel, and although of considerable size, is still not nearly so copious, as might be expected from a glacier of such extent as that of the Inylchek. Both observations were clear indications, that the Kayndy could not be the

Digitized by Google

great longitudinal valley, that I was seeking. The enclosing walls are composed of a series of light and dark limestones, several beds being exceptionally rich in fossils, which, however, have been crushed and squeezed by contact with the diabase. Still some of the collected samples may perhaps be identified. Diabase of diverse structure, horn slates *(Hornschiefer)*, diabasic tuffs, are of frequent occurrence in the boulder drift, while higher up the valley, highly metamorphic clay-schists and sandstones were again met with. Strange to say, no marbles occur in the whole zone of the glacier. But the stratigraphic relations are very complicated, and Herr Keidel thought he recognised scale-structure during his visit to the middle parts of the valley in the previous year.

For the first quarter of its course the Kayndy glacier is also covered with a mass of detritus, though far less extensive and less thick, than that of the Inylchek glacier. After three or four miles the ice becomes free, and here very uneven, which, however, is rather the result of erosion from the running waters, than the effect of pressure. Farther up the ice is smooth. It has an average breadth of 2,300—2,600 ft. (700—800 m.), with a total length of twelve to thirteen miles, a very winding form, and a slight incline. On the left margin several green tarns fill depressions in the ice. Worth mentioning, as a rare phenomenon in the Tian-Shan, is a lofty and copious waterfall in the right scarp of the valley. On the left bank a verdant terrace, over-

Digitized by Google

grown with cargana-bush, still skirts the ice some five miles upwards.

As a result of my exploration it became evident, that the Kayndy glacier extends only for a short stretch north-eastwards parallel with the Inylchek glacier; it is soon closed in by the already-mentioned spur (*vide* p. 204), which branches off below the mouth of the granite-bearing lateral valley of the Inylchek glacier from the southern scarp of this valley. The significance and trend of this spur, which I had not clearly understood till now, became clear, and the absence of granite in the Kayndy valley was now also explained. *The Kayndy valley is thus shown to be merely interposed between a much longer longitudinal valley and the Inylchek basin.* A deep gap in the completely glaciated mountain wall, enclosing the head of the Kayndy valley, might give access to, or at least afford a view of, this more extensive longitudinal valley confining the Kayndy valley. The range forming the northern scarp of the glacier, is crowned by a series of fine snowy peaks, which cannot be seen from the Inylchek, because, as I have already pointed out, the parting wall there ramifies into two parallel spurs. On the other hand, one of the highest of the Inylchek mountains is visible through a gap from the Kayndy glacier. The southern scarp of the valley is likewise glaciated to a considerable extent, but is lower than the northern. It is here that the Tian-Shan *massif* begins to slope southwards (*vide* pp. 41, 47, 67), and while the

Digitized by Google

SUMMIT OF KHAN-TENGRI (ABOUT 23,600 FT.) NORTH-WESTERN SLOPE. TELEPHOTOGRAPHIC VIEW FROM A GAP (ABOUT 14,000 FT.) BETWEEN KARAKOL AND THE WESTERN BAYUMKOL GLACIER. DISTANCE ABOUT 7½ MILES (SEE P. 80).

HEAD OF KAYNDY GLACIER. [*To face p.* 222.

Digitized by Google

UNIV. OF
CALIFORNIA

Digitized by Google

northern range forms a mountain mass rarely carved by a valley, the southern range is cut up by numerous ravines, disposed obliquely to the long axis of the valley. Several small and two large lateral glaciers descend through these ravines towards the main glacier, but none except the two large ones now reach it. No indications could be discovered of any shrinkage of the glacier in recent times. But what a poor survival the present glacier is, when compared with its former extent is shown by traces, filling the whole valley. For some stretches the old moraines rise to two-thirds of the height of the enclosing walls—that is, to 2,000 ft. (600 m.) above the bed of the valley.

From a point in the enclosing wall on the left side, some 3,000 ft. (1,000 m.) above the glacier level, a panoramic view was obtained of the glacier and of the encircling ranges.

In order to visit the next large parallel valley, I resumed my wanderings, and made my way down the valley for twenty-four miles, from the tongue of the Kayndy glacier. In its middle course the Kayndy valley is distinguished by a wealth of rich grazing grounds, pine-groves, and a very fine and varied flora, such as one does not expect to meet with in a southern Tian-Shan valley. Here, too, the intruding diabasic rocks have variously transformed the schists and limestones of the cliffs enclosing the valley. About twenty miles below the end of the glacier, where the valley contracts to a ravine, it bends sharply

Digitized by Google

round to the south-west, and at the outlet of the ravine, which is two miles long, forms a basin-shaped enlargement, where the left bank is occupied by recent deposits 130—160 ft. high, consisting of very coarse-grained, hard red sandstone. This passes to a still coarser yellow-brown sandstone, and farther west to conglomerates, overlain by later compacted drift, above which loess has been deposited. The conglomerates, forming steep walls, skirt the further course of the river for many versts on both sides. The sandstone strata show slight dislocations and their strike is discordant to the limestones of the ramparts enclosing the valley. On the history of at least a part of these recent deposits in the Tian-Shan I have evolved a theory of my own, which differs in some respects from that, hitherto entertained. I cannot, however, justify and elucidate it within the limits of this summary report, and must, therefore, reserve it for the detailed report.

Digitized by Google

CHAPTER XIX

FROM THE KAYNDY VALLEY OVER THE UCH-SHAT PLATEAU TO THE KOI-KAF

In the middle course of the valley the range, skirting the left bank of the Kayndy, appears to resolve itself into a series of spurs, running north-west and south-east, and bearing rugged summits, clothed with abundant glaciers. One of them displays a remarkably bold form, like a diminutive Khan-Tengri. Between these ridges a number of short, high-lying valleys are indentated, all collectively called Kara-bel by the Kirghiz; only through the most easterly of these valleys, is it possible to cross the mountain range towards the south. Between the deep bed of the middle Kayndy valley in the north, and the much more deeply excavated bed of the next parallel valley in the south, there stretches an almost plateau-like flattened ridge, covered with Alpine meadows, in the water-parting range, which forms an extensive depression between the series of peaks, ranged farther up and down the valley. The slope of this broad, flat ridge, gently inclined towards the Kayndy, is disposed in blunt ribs, divided by level trough-like upland valleys, which, however, are more deeply excavated where they approach the edge of the plateau; this falls

Digitized by Google

in high, steep declivities down to the level of the main valley. Formerly, when this was filled with glacier ice, the lateral ice-streams, descending from the nevé once covering the plateau with but gentle incline through these troughs, joined the main glacier at a great height. The present relief of this upland region is entirely the result of glacial agencies. On the other hand, the far steeper slopes, facing southwards are intersected by deep, impassable ravines. Between both slopes there stretches a broad whale-back, inclined somewhat towards the south-west. In this very gently sloping flat top is sunk a shallow cauldron, opening to the south-west, where the waters, converging in their descent from various directions, are collected in three channels, which in their turn unite still farther down in a single course. The Kirghiz, who find good summer pasture in this Alpine region, call it *Uch-shat*, "Three Valleys," and the transverse chain of variously shaped, snow-clad summits a little farther west, they call Uch-shat-Tau. The main stream, formed by the three converging rivulets turns south and south-west, and soon disappears in a "nullah," the course of which I was unable accurately to determine. The Kirghiz say it joins the Sary-jass, here descending from the north.

Thus the flat, truncated ridge about 13,000 ft. (4,000 m.) high, where the sources of the Uch-shat river rise, forms the crest of the plateau region, but this, as has been stated, is the lowest part of the dividing range between the middle Kayndy and

Digitized by Google

the next southern parallel valley. A depression about 12,300 ft. (3,750 m.) high in this crest is the *Kara-archa* pass, so called from the dark growth of bushy *archa* (*Juniperus sabina*) on its southern slope. This pass alone gives access to that southern parallel valley, that the Kirghiz call *Koi-kaf*—that is to say, "Sheep-sack," "sack" alluding to the narrow, closed form of the valley, while Koi (="sheep"), means that sheep are driven hither to graze. The Kirghiz, at that time residing in the Kayndy valley, told me it was so long that nobody could get to its end, and so narrow and so completely filled with rushing water that it was not passable in summer; that a very large glacier and much snow stretched away in the background, where there are very high mountains. In winter, however, when the water is very low, the Kirghiz drive their sheep over the Kara-archa pass down the valley, and then thirteen miles up in the Koi-kaf valley, which hitherto ravine-like, broadens out and offers some poor grazing-grounds, with the sour steppe herbage preferred by the sheep. They told me, also, that owing to its low level and narrow enclosure, as well as to its position, extending far to the south, this spot is warm and nearly free from snow—a good wintering place for the flocks.

Now, it was for us to discover for ourselves, whether it might not withal be possible for Alpine climbers to penetrate into this valley, which, from all that I had seen and heard, must be the large southern valley I was seeking, running parallel to

Digitized by Google

the Inylchek. By the narrow mouth of the first Kara-bel valley, cut in between huge cavernous conglomerate walls, we made our way to a trough-like expanse, encircled by grass-grown morainic ridges. These stretch along the foot of an imposing, picturesque rocky wall, crowned by glaciers, where dark diabasic cliffs stand out in the foreground, strongly contrasting with the masses of light limestones and marble-schists rising behind them. The route now lay over steep morainic ground towards the south-east, and over the crest of a ridge between two parallel troughs, to a pass (Kara-bel pass) about 11,500 ft. (3,450 m.) high, then southwards down toward the Uch-shat as far as the converging point (about 10,500 ft.; 3,250 m.) of the three streamlets, and so up through the easternmost of the three valleys, between much disturbed chloritic schists and sandstones, where we established our chief camp (about 11,500 ft.; 3,500 m.), on the slope immediately below the Kara-archa pass. From this point I crossed the pass (about 12,300 ft.; 3,750 m.), and by a difficult descent southwards, reached a region drained by two streams, which unite farther on and then lose themselves in a deep, narrow gorge. In order to turn this obstacle, we surmounted two ridges, about 10,500 ft. (3,250 m.) and 11,000 ft. (3,400 m.), projecting high above the yawning chasm, and then descended some 2,500 or 3,000 ft. (800 or 900 m.), by an unusually steep track, down an escarpment directly to the bottom of the gorge. Here we traversed for some distance

Digitized by Google

a zone of sedimentary rocks—limestones, greatly decomposed, and metamorphosed dark and light clay-schists with interstratified diabasic schists. From the pass and from the two ridges we commanded partial views of the highlands. Towards the south and south-east, narrow, deeply cloven rocky crests, running apparently in wild disorder close together and but sparsely clad with snow and ice, are intersected by ravines of enormous depth. It was difficult to get a clear grasp of the dominant features in the general relief of these crests. We were, however, able at least to follow the ridge lines of the border-ranges along the course of the Sary-jass. But the intervening crests were too near our standpoints, and these were not elevated enough, to afford a view of the ice-clad regions of the Sabavchy and Kumaryk, especially in the then clouded state of the atmosphere. On the east side, the mountain mass was cut up in a surprisingly diversified way by erosion, confined, however, to the formation of glens and gorges at a high level. The process of their development seemed to be suddenly arrested, and they are now mostly dry and even free from snow, having failed, so to speak, in their intended vocation.

The Kara-archa gorge, at first from fifty to sixty-five feet wide, soon contracts to thirty, and in places even to twelve feet. Its bed, thickly strewn with rock blocks, is swept by the swirling waters of the Kara-archa torrent. Vertical white marble walls, 1,800—1,700 ft.

Digitized by Google

(400—500 m.) high, partly in thick slabs, partly in schistose beds set at a high angle, enclose the tortuous defile, in whose dim light could be seen the most magnificent dome-shaped hollows scooped by the water. Most amazing bendings, twistings, and burstings are shown in the strata of these steep ramparts. Moreover, the extraordinary extent of the weathering and destruction often gave the impression that the masses, now hanging loosely together, might topple over at any moment. Nevertheless, the remains of a ruined vault may be recognised from the strike of the strata and the angles of incidence. Beds of conglomerate, whose material consists exclusively of white marble fragments, bound together by white cement, extend some height up the rocky walls, and numerous huge blocks of such conglomerates often obstruct the way in the bed of the stream, while others, already loosened, threaten to tumble down. Morainic drift is also found in the gorge, deposited on ledges along the marble walls. Beside the conglomerates, the material in the river-bed consists nearly exclusively of white marble and green phyllite. During my long wanderings in mountain regions I have scarcely anywhere seen more chaotic forms than in this ravine, which are all the more remarkable from the material, of which the mountains are here built up. It is interesting to note that, at an average height of 500 ft. (150 m.) above the present bed of the gorge, blocks of loose conglomerate are still preserved on small terraces of the steep

Digitized by Google

ramparts, and thus show the former level of the Kara-archa stream. By this difficult route we were led some two and a half miles (four versts) through the cañon. A little beyond its southern outlet a remarkable geological picture was presented—thick beds, alternating with slabs, both of very dense unfossiliferous limestone, the core of a worndown fold, whose strike (N. by 50° W.) is completely enclosed by the system of the far more vertically disposed, marble-like limestones and schists, which strike N. by 60° E. I have fixed the remarkable site by a photograph, and was able to follow this old fold farther on in the rocky walls running north-west and south-east.

The cañon, in its roughly southern course, broadens into a valley from 260 to 300 ft. wide, and is encircled by bare, rugged walls of brown limestone, 3,600—4,000 ft. (1,100—1,200 m.) high. After a short course it is shut in by a still more elevated precipitous, rocky mountain range, striking from north-east to south-west across the axis of the Kara-archa. The traveller hears a mighty roar of swirling waters, but does not see the stream, rushing in a deeply excavated bed along the very foot of the steep, rocky barrier, until he has approached close to the brink. This is the longitudinal gorge of the Koi-kaf, which is joined on its right bank by the transverse cleft of the Kara-archa. No doubt a volume of water, such as is discharged through this fluvial bed, can owe its existence, in a region of such slight precipitation, only to some very extensive and

Digitized by Google

lofty glacier region. But in the winding gorge, some sixty-five feet (twenty metres) wide, through which the river rushes along, one could see only a little way up or down stream, the distant view being blocked by steep rocky walls.

I had our little mountain tent now set up on a small terrace (about 7,000 ft.; 2,150 m.) near the confluence of the Kara-archa. In its complete seclusion—a kind of a cirque, enclosed on all sides by wild, overhanging rocky cliffs—the site was highly romantic, but appallingly desolate: loose loess soil, much boulder drift, mounds of waste, fluvio-glacial débris, a chaos of blocks in the river-bed, running waters on both sides, the only growth the stunted scrubby vegetation of the southern deserts and stony steppes! For the copious streams, here rushing by, leave no fertilising effects behind; the ground remains dry, dusty, parched. Seldom have I seen in the mountains a more arid valley. The air was dank, oppressively sultry, the worry intense from stinging gnats. Gusts of wind, coming at times from the gorge, as from a blast-furnace, enveloped us in clouds of loess dust. Our stay in such a place was extremely unpleasant, especially at night, with its stifling, heavy atmosphere and tormenting, winged pests, from which there was no escape. The sky was veiled, owing to fine loess-particles, whirled aloft and floating in the air; one could hardly distinguish the lofty crest-lines of the rugged walls. These unfavourable conditions hastened our operations. We forced our way up

Digitized by Google

the river-gorge alongside its seething water, but after four versts of strenuous efforts found the way blocked by the impassable current, running close under the winding rocky walls. We tried to overcome the obstacle by forcing a passage high up on the cliffs; but here the gorge describes such narrow windings, that we soon found ourselves again barred by a like obstacle at a bluff surrounded by water. Moreover, all clambering over the smooth marble cliffs soon became impossible. And when the eye followed the sharp bends described by the crests of the enclosing ramparts, it was soon seen that this serpentine course was continued very far up the valley; the undertaking had therefore to be abandoned as hopeless.

The Kirghiz were right after all; nevertheless, I decided, in order to get a view of the upper course of the valley, to climb a high eminence in the steep enclosing walls. From such an elevation, from which in any case the snowy ranges of the Kum-aryk and Sabavchy region would be visible, it would doubtless be possible to ascertain the relation of the Koi-kaf to those valleys. But this also proved useless, as the atmosphere had grown so much thicker, that even the nearest crests were almost veiled in mist. Owing to the fine loess dust, constantly rising, the air is probably here generally hazy; but now, a heavy barometric pressure having set in, there was added a vapoury cloud, which prevented me from getting a view of that most mysterious region of the Tian-Shan.

Digitized by Google

With a heavy heart I decided to return from this inhospitable region. I should have willingly endured the discomforts of a few days' further stay in that desolate region, if I could have hoped for any satisfactory results. But the weather forecast was too unfavourable.

As it was, I could not have been very far from the opening of the Kum-aryk valley on to the southern plain, since I now stood only about 1,300 ft. (400 m.) above its level. One could also perceive from the contours of the lofty crests, that those valleys, which I had visited some months ago, could not be far off. Had it been possible to descend by the ravine, the mouth of the Kum-aryk could easily have been reached in a single day, however intricate might be the windings of the gorge. The Kirghiz were able to assure me, that the waters of the united streams turn several times sharply to the west, and again suddenly to the east, thus often flowing towards each other in narrow curves. This they knew of old, though none of them had yet traversed the narrows. The question uppermost in my mind was whether the Koi-kaf might be identical with the longitudinal Ak-su valley of the forty-verst map (*vide* p. 157). Were this not the case, then the Ak-su could only be the next parallel southern valley.

From the character of all these valleys, which, south of the Kayndy, are mere cañons, and from the carving of the mountain masses, which is limited to their upper parts, a point I have already referred

Digitized by Google

to (*vide* p. 229), it follows that the formation of real valleys in this part of the Central Tian-Shan has been prevented by the intervening and rapidly increasing dryness of the climate. There is nothing to wash down the sides of the valley, while the discharge from the great glaciers, descending rapidly by the main channels, excavates their beds deeper and deeper, and the form of the cañon is no longer eroded laterally to the profile of a real valley.

At the very first glance at the bed of the Koi-kaf river I noticed a pretty considerable quantity of granite, and that, too, of the same kind as is found in the moraine on the left side of the Inylchek glacier. This was a further proof, that the granite *massif*, which supplies its moraine material to the Inylchek through a lateral valley, connecting both, must appear also in the Koi-kaf valley, and hence this must be the great channel, which stretches parallel to the Inylchek far to the east. As, however, the central main range, which undoubtedly likewise encloses the head of the Koi-kaf, is formed, as proved beyond question, of sedimentary rocks, and as the lower and middle course of the Koi-kaf valley is likewise enclosed by like materials, the granite would appear to occur in this valley in the form of a "stock."

Possibly these granite masses may also be connected in some way with those, observed in the Sabavchy valley. *But from all my researches it results that the Koi-kaf must be the large longitudinal valley I had been in search of, which,*

Digitized by Google

bending round the Kayndy valley, acquires in its upper course a considerable breadth, and there contains a glacier, which must be about as extensive as that of the Inylchek.

From all the observations made, both on the north and the south side, I must also conclude that the southern bounding range of this large longitudinal valley is also connected at or somewhere near the Peak Nicholas Mikhailovich with the main range. Unfortunately, the unfavourable conditions prevented me from acquiring greater certainty on the structure of this part of the Central Tian-Shan, and a gap consequently still remains in my knowledge of the actual relations. On our return to the chief camp in the Uch-shat valley, fierce snowstorms set in and also accompanied us on our return to the Kayndy valley, which was now surveyed for another stretch of about ten miles (fifteen versts) to its junction with the Sary-jass. On this route, as well as during our course through the Sary-jass valley up to the confluence of the Inylchek and throughout the entire length of this valley up to the Tys-ashu pass, our observations were unfortunately greatly impaired by the cloudy weather and by the thick mantle of fresh snow shrouding the heights.

Digitized by Google

CHAPTER XX

THROUGH THE KAYNDY VALLEY TO THE SARY-JASS AND INYLCHEK AND BACK TO THE TEKES.

THE ranges skirting the Kayndy valley fall gradually towards the channel of the Sary-jass, which intersects them transversely. Nevertheless, the architecture of their crests presents a rugged aspect and is serrated by deep gaps. The remarkable tendency of the southern border-range to resolve itself into transverse ridges, running north-west and south-east, already mentioned (p. 223, 225), which is in sharp contrast to the generally ruling direction of strike, could here also be observed. For some distance the valley is blocked by vast accumulated masses of fluvio-glacial drift, through which the river cuts its way in a narrow gorge. Farther down the valley these masses of drift take the form of long terraces. Here the evidences of the ice age are specially conspicuous. Granite blocks of enormous size rest on the top of these terraces, though granite does not enter in the structure of the surrounding walls. Green, grauwacke-like sandstones, limestones, and phyllitic schists form the encircling walls, along which are deposited great quantities of conglomerates on both sides of the valley.

Digitized by Google

Where the Sary-jass is joined by the Kayndy, the bed of this river not being fordable, the wayfarer is compelled to scale the steep scarp of the left bank, here about 400 ft. (120 m.) high. It projects like a headland in the angle, formed by the junction of the tributary with the main stream, a fine prospect of which is commanded from these heights. Facing northwards, we first behold the sinuous contours of the crests of the Kulu-Tau, and Sary-jass-Tau, between which the stream in its north to south course winds along in an inaccessible gorge until it breaks out into a wide open valley a little above the confluence of the Inylchek. The valley now assumes a general south-south-west trend; and has an average breadth of a mile, and a mile and a quarter at its widest part. After a course of about ten and a half miles (sixteen versts), it again turns south and even south-south-east, and once more contracts to a narrow gorge as it forces its way through the Ishigart-Tau range. Here the stream again disappears between the projecting and retreating angles of the shifting mountain curtains. It does not reappear until it once more breaks through the narrows as the Kum-aryk, on the southern slope of the Tian-Shan (*vide* p. 148).

On its open course the main stream is joined from the east by the Kayndy (confluence about 7,900 ft.; 2,400 m.), and eight miles (twelve versts) farther up by the Inylchek (confluence 8,500 ft.; 2,600 m.). On the west side it is joined, nearly at the same level as the Kayndy, by the Uch-

Digitized by Google

kul,[1] which also flows from a longitudinal valley, in its upper course called Yir-tash, on the source of which I have reported, p. 178, and two miles (three versts) below the confluence of the Inylchek by the Terek-ty. This river likewise discharges from a longitudinal valley, but, despite its importance, is, strange to say, entered in none of the maps.

The enclosing walls of the Sary-jass valley, as long as its course is open, consist on both sides of walls only about 2,000 ft. (600 m.) high, the ranges through which the river here cuts transversely being much depressed towards the channel. They consist of black, slabby, dense and unfossiliferous limestones, which have a N. by 20° E. strike, falling to 40° S.E., and on both banks show the same stratigraphic relations.

On the right bank at the foot of these ramparts are three excellently preserved longitudinal terraces, developed in the masses of drift about 130 or 160 ft. one above the other, and all of considerable breadth with perfectly level surfaces. On the left side, on the contrary, the river approaches very near to the mountain side, and flows between the steep scarp of the lowest terrace of the right side, and the equally steep slope of the terrace (about 160 ft. high) which

[1] The lower course of this river, eastward of the confluence of its tributary Orto-uch-kul, joining from north, is called Uch-kul. West of this confluence, it bears the name Yir-tash. This I was informed by the Khirgiz, sojourning in the Kyandy valley, opposite the mouth of Uch-kul, and also by those, camping on the Syrt plateau close to the head waters of Yir-tash.

Digitized by Google

extends only as a narrow belt along the rocky wall of the left bank. Here the river occupies a bed some 230 ft. (70 m.) wide, which—at least, when I traversed the valley—was completely flooded by the stream. This narrow terrace soon disappears altogether, and in order to reach the mouth of the Inylchek we had to pass along narrow ledges of the rocky wall some 500 ft. (150 m.) above the foaming torrent. Here, on narrow projecting terraces and cornices of the limestone cliffs, I saw the remains of boulder drift containing large blocks of granite, and on other still more elevated ledges and recesses I observed stratified beds of gravel and sand sixteen inches (forty centimetres) thick, well preserved indications of the changes of level that have here taken place.

In the *Mitteilungen* of the Imp. Royal Geograph. Soc. of Vienna, vol. xlix. 1901, Dr. G. von Almassy has suggested the possibility, that the waters of the Sary-jass, at that time pent up as a large lake, may have formerly flowed over the watershed of the Myn-tyr-Syrt away to the north, and were only later deflected to their southern course, when the northern outlet was made impossible by upheavals. Here I will not discuss the question of the former existence of a lake, having the compass assigned to it by Dr. von Almassy; nor will I positively deny the possibility of the northern outflow being shifted, for instance, by ice, or accumulated deposits of drift. It must, however, be pointed out, that the profile of the Kok-jar valley does not at all

Digitized by Google

suggest that at one time such a potent volume of water, as would accord with the size of the former Sary-jass, was really discharged through this channel. And we should still have to ask, if the present channel of Sary-jass at that time did not exist, what was the course then taken by the large affluents of the Sary-jass—Inylchek, Kayndy, Koi-kaf, etc.—of which the Inylchek alone is more copious than the main stream? Westwards to the Naryn basin? Considering the conformation and relief of the local mountain system, such an outlet is scarcely conceivable. Besides, what could have caused these rivers to be deflected altogether from their east to west to an almost southerly course? Lastly, we should have to consider the weighty circumstance that the mountain ranges, which flank the east and west tributaries of the Sary-jass along their course, all slope quite gradually, but still very considerably, towards the furrow of this river (*vide* pp. 237, 239), while no great significance can be attached to the presence of a lofty summit, rising at the east end of the Kulu-Tau. So much for the present on this interesting question, to which I shall return in the detailed report.

The section from the confluence of the Inylchek to the Tys-ashu pass is about forty-two miles (sixty-three versts) long, so that we may estimate the length of the whole valley up to the head of the glacier at some ninety miles (135 versts), including the windings. In the lower course the average breadth of the valley is one mile, but here

Digitized by Google

basin-shaped expanses, up to a width of two miles (three versts), alternate with contracted beds no more than 650 ft. (200 m.) or even 500 ft. (150 m.) wide at the already-described ancient barrier (*vide* p. 68)—the last remains of the limestone cliffs, which represent the remnants of the collapsed over-arching strata, not yet swept away by the current. The incline is extremely gentle, scarcely more than thirty-five feet per mile (six metres per verst), and the ranges skirting the lower course have decreased very considerably in height. Nor, in the region of their crests, do they any longer show any special developments or varied contours. The formation of summits is reduced to broad, dome-like prominences of the plateau-shaped surface, and glaciation is now slight. While the chain on the south bank is much diversified by little upland glens, whose openings stand high above the present level of the valley, the northern range presents an almost continuous rampart. From the observations I have already adduced, it appears that in all these longitudinal valleys trending east and west, the same phenomenon is repeated: The northern slope, with its abundant snow and water, is greatly eroded; the slope facing south is dry, and to no appreciable extent ravined. The valley exhibits in general a steppe vegetation, though the herbage is abundant and in places very rich, while along the rocky walls of the southern range excellent Alpine meadows of great extent alternate with considerable stretches of pine forest. In the

Digitized by Google

lower valley also the old moraines have acquired a very important development. They reach very high up the sides of the valley; on their flat tops enormous blocks of granite, diabase, limestone and marble have been deposited. Here the constituent elements of the ranges are semi-crystalline limestones, sandstones, porphyries and highly metamorphosed schists of very diversified types. The results of marked lateral pressure are constantly observable in the series. Of old igneous rocks I was certainly able to notice granite and syenite in some places along the middle course of the valley, but as already stated (*vide* p. 236), my observations were impeded by the cloudy weather and the thick mantle of fresh snow on the heights.

The great glacier was already veiled beneath a uniform covering of snow. Still, near the Tys-ashu pass I had the good luck to discover a coralliferous bed. I selected this pass also for the return, because it presents the shortest way to the northern slope. For the last time, the weather clearing up, I enjoyed from the summit of the pass the view of one of the grandest ranges in the world—an unbroken chain, over fifty miles (seventy-five versts) long, of wonderfully glaciated peaks, rising in solemn majesty with hard, steel-like contours into the cold, clear autumn air of the parting day.

The summer was drawing to a close, and renewed snowstorms might any day put a stop to my researches in the high regions. The Tys-ashu valley and its surroundings already (September 12th) lay shrouded in a continuous sheet of snow

Digitized by Google

sixteen inches (forty centimetres) thick. In the Sary-jass valley only the lower part of the southern slopes was still free from snow. Crossing by the Myn-tyr pass, the upper Kok-jar valley (Kuberganty), the Kapkak pass, and traversing the like-named valley, I again reached the Tekes valley. Great was my surprise and satisfaction to find here and in the transverse valleys, branching from the Tekes into the highlands, even the high grounds still free from snow, as well as a general temperature much higher than on the south side.

Digitized by Google

CHAPTER XXI

TO THE BAYUMKOL AGAIN AND THEN TO THE LITTLE MUSART VALLEY

At once seizing the opportunity, I, for the third time, visited the Bayumkol, my object now being to replace the valuable photographic views, which had been lost the previous year in the waters of the Musart river. The work was effected without disturbance. From a summit about 14,400 ft. (4,400 m.) high at the northern edge of the western glacier, as well as from a crag 15,000 ft. (4,600 m.) high on the northern edge of the eastern glacier—clear autumn skies having succeeded a few stormy days—we were able to take a series of important telephotographic views, besides several panoramic ones, shedding light on the ramifications of the central crests, radiating from Mount Nicholas Mikhailovich. Special interest was presented by the view from the heights reached by me, showing the superb head of the Little Musart or Saikal valley, completely buried in nevé and ice. But it was seen to be indispensable to traverse this valley, in order to verify its hitherto assumed connection with the main watershed. The scanty representations given on the forty-verst map in respect of this

Digitized by Google

and the neighbouring valleys stand in too violent antagonism to everything, that I had hitherto seen. Hence, the next task, that I proposed to myself, was a survey of this large transverse valley, which had not yet been visited by any explorer.

The entrance to the Little Musart valley was reached from the Narynkol Staniza (Okhotnichi) by a south-eastern route, six to six and a half miles (nine or ten versts) long, across the rich, grassy steppe of the Tekes plain. The river fed by the glaciers of the valley is one of the most copious mountain streams on the north side. It is difficult, at times impossible, to cross. It differs from many other Tian-Shan rivers in that, all the way up to its upper course there are no branches, but only a single artery everywhere. Large quantities of drift have been discharged from the wide opening of its valley, about 6,900 ft. (2,100 m.) high, far into the Tekes plain, where they are disposed in thick terraces on both sides of the valley-mouth. In the valley itself they form a flight of three verdant steps, running for some distance parallel with the river-bank. Along the lower course the escarpments of the valley are formed of limestones, which are pierced by a porphyry zone one and a quarter miles wide. Owing to the extensive mantle of morainic detritus, overlying the escarpments, a large section of the valley presents for the most part soft, rounded forms. Excellent Alpine pastures, favourite wintering places of the Kalmuks, alternate with extensive stretches of dense pine-forest,

Digitized by Google

VIEW TO THE HEAD OF SAIKAL VALLEY FROM A RIDGE (ABOUT 13,500 FT.) IN THE EASTERN BAYUMKOL GLACIER.

First chain: bordering the Bayumkol glacier to the east. Second chain: encircling the head of Saikal valley. Third chain: main watershed.

[*To face p.* 246.

Digitized by Google

Digitized by Google

often interspersed with leafy growths (mountain-ashes, willows, etc.). The general aspect is almost that of a fine northern Alpine valley.

Four and a half miles (seven versts) above its mouth the valley forks into two branches,—one, called the Uertenty, running south-south-east and south-east; the other, the Saikal, stretching southwards. To judge from the volume of water discharged by the two streams, the Saikal basin contains the more extensive glaciers. The level of the Uertenty valley lies at the forking, 130 ft. (40 m.) higher than that of the Saikal, here about 7,200 ft. (2,200 m.) high, down to which it falls abruptly. The lower course of the Uertenty has a ravine-like form, is densely timbered, and of difficult access. In its middle course the valley broadens out considerably, the bottom and slopes clothed with Alpine meadows; it there receives numerous affluents, which, in the cirque-like basins at their sources, harbour small glaciers, while the main valley, with a total length of about twenty-six and a half miles (forty versts), is filled for the last quarter of its course by a glacier about six and a half miles (ten versts) long. This is nourished by the nevé of an already described (*vide* p. 15) plateau-like secluded mountain mass, encircled by lofty, many-peaked ranges, which stretches as a water-shed in the angle between the heads of the Saikal valley, of the Mukur-mutu valleys, and of the Dondukol valley, the largest affluent of the Great Musart river (*vide* pp. 83, 85). In this region, which once was in its whole extent covered by

Digitized by Google

ice, erosion has not carried the process of valley-carving very far, only high-lying valleys being excavated. Towards its head the highest glaciated trough of the Uertenty valley connects with that of the east branch of the Saikal valley, of which more anon.

A little beyond the forking the Saikal contracts to a ravine, averaging a hundred feet (thirty metres), and in places not more than thirty feet (ten metres), in width. Here the steep limestone walls are occupied to a great height by many thousands of dead pine-trees, the result of a forest fire. Great numbers have fallen down, thus further obstructing the copious current in the narrows, where it was already impeded by large boulders. Hence this cañon, from three to four miles (five to six versts) long, is very difficult to traverse, and quite impassable in spring and summer, as at these seasons the narrow channel is flooded house-high by the melting snows. In this deep gorge the air is stagnant, oppressive, and the decaying, exuberant vegetation, growing in all the cavities and on the ledges of the cliffs produces a stifling atmosphere. At the upper outlet of the gorge the valley gradually broadens out to a considerable extent. A picturesque aspect is there imparted to the valley by the extensive old morainic deposits of the main stream, with those carried down by the numerous lateral rivers, all much intersected by erosion channels and carpeted with beautiful Alpine meadows, dense pine-woods of great extent, and a quite luxuriant bush vegetation. The lateral

Digitized by Google

valleys are for the most part narrow glens, which, farther back, expand to glacier-filled cirques. Limestone still forms the enclosing ramparts, which, in the parting-wall between the Saikal and the Bayumkol, assume the form of an abrupt serrated crest, set with small glaciers. This wall is pierced about sixteen miles (twenty-five versts) above the forking of the river by a broad, glacier-bearing valley, at whose head a high pass leads to the Alai-aigyr, an affluent of the Bayumkol which has already been referred to (p. 27). From this point gneiss begins to form the escarpments of the valley and reaches nearly to its head, often passing into granite, and this again into gneiss. Owing to the but slightly inclined bedding of the gneiss (averaging about 40°), the contour lines of the crests seldom exhibit rugged forms or deep indentations.

Some twenty miles (thirty versts) beyond the forking of the valley, it is joined on the (orographical) right side by the most copious and important of its affluents, which, in its many-branched course of about thirteen miles (twenty versts), leads to the high Saikal pass, giving access to the Uertenty valley. At the confluence of that lateral valley its old moraine drifts have been heaped up on an earlier terminal moraine deposited by the retreating glacier of the main valley. Behind this elevated barrage the waters of the Saikal were once damned up into a large lake a mile wide. The (orographical) left side of this basin is joined by a steep glaciated valley, some ten miles (fifteen versts) long, which ramifies at

Digitized by Google

its head into two branches, one coming from the south, the other from the south-west. One of these has its source on the nevé saddle of the eastern Bayumkol glacier, where our high camp had stood the previous year, while the other takes its rise in a glacier basin, lying to the north of it.

Towards its head the Saikal valley, altogether about thirty miles (forty-five versts) long, is divided by old terminal moraine walls, piled up by the periodically retreating glacier, into several round level tracks, on whose gravelly flats the river, hitherto confined to a single bed, now ramifies. The clumps of pines, standing on the old moraines, which rise in terraces one behind the other, contrast sharply with the dazzling white of the completely ice-clad cliffs, which here enclose a broad cirque and apparently form the head of the valley. At the foot of these unusually torn and tossed ice-walls, rising into superb peaks some 8,200 ft. (2,500 m.) above the valley level (itself about 10,000 ft.; 3,000 m.), the picturesquely crevassed glacier, completely free of débris, bursts out like a cataract and, after a short course down the valley, ends at the altitude of 9,700 ft. (2,950 m.) in a terminal ice wall 160 ft. (50 m.) high. The glacier tongue is fringed on the left by a dark belt of scrubby vegetation. Not till he approaches the wall on the (orographic) right bank, does the observer perceive that the valley again bends round to the east-south-east, and that the glaciated walls, which really enclose

Digitized by Google

the head of the valley, and are similar to, but 1,800 or 1,600 ft. (400 or 500 m.) lower than, those just described, lie some miles farther on in that direction. In order to reach this uppermost cirque a barrier of old morainic boulders, about a quarter of a mile broad, has to be surmounted. Then, by a steep descent, we reach an oblong basin which is from 2,000 to 2,800 ft. (600—700 m.) long, and 1,800 to 1,600 ft. (400—500 m.) broad, being enclosed on three sides by glaciated walls, and on the fourth blocked by the above-mentioned morainic deposit. Through this barrier the river cuts its way in a narrow cañon, beyond which it ramifies over a tract perfectly levelled by the fine limestone and schistose drift deposited on it. Here, also, the ramparts, enclosing the head of the valley are composed of limestone, marble, and dark clay-schists; they do not belong to the main central range, but to a chain running parallel with it, which forms the northern wall of the large glacial valley, that stretches from Mount Nicholas Mikhailovich towards the Musart pass, and was discovered by us the year before (*vide* p. 82 *et seq.*).

At its east end the above-described basin is joined at the level of the valley (about 10,000 ft.; 3,100 m.) by the tongue of a large glacier, which emerges from a breach in the ramparts, and fills the bed of a rather narrow valley, about thirteen miles (twenty versts) long, coming from the east-south-east. It has its source on the same elevated plateau-like mountain mass as the Uertenty valley, encircles in its bending course the uppermost

Digitized by Google

nevé basin of this valley, and at its head joins that of the Dondukol valley. From the plateau several smaller glaciers descend at steep angles between snowy peaks to the main glacier.

The Uertenty valley itself intersects another high valley, the Maralty, which, traversing the above-mentioned plateau latitudinally, debouches in the Dondukol (*vide* p. 17). If that long glacier really be regarded as a branch, or as the highest source, of the Saikal, for its waters are drained by this stream, then the Saikal valley will have a total length of about forty-three miles (sixty-five versts). The existence of such extensive glaciers in this part of the Tian-Shan was hitherto unknown.

The elucidation of these intricate orographic relations could not, of course, be effected merely by traversing the Saikal valley. Not until we had scaled a snowy peak 14,800 ft. (4,500 m.) high, in the dividing wall between Saikal and Uertenty, was I able to get a clear insight into the relief of this section of the highlands, but here I succeeded in completing the observations, made from the heights in the eastern Bayumkol and in the Mukur-mutu district. As on the first ascent of the peak the atmosphere became murky, it had to be repeated two days later. Telephotographic views, obtained from this eminence supplied solid materials for these observations. The photographs, already taken from the Bayumkol valley eastwards, are now supplemented by the panoramic photographs, looking westwards from the Saikal peak. As these operations were later continued eastwards from elevated

Digitized by Google

standpoints at the head of the Mukur-mutu and of the Dondukol valleys, I have secured, for the whole tract from the Sary-jass to the Great Musart valley, an unbroken series of panoramas, representing the central highlands, and verifying each other. These will form an excellent complement to the topographical work, in which the details were obtained by photogrammetry. Added to all this are the special panoramas of the great mountain ranges, extending from the Sary-jass southwards to the Kayndy valley.

Digitized by Google

CHAPTER XXII

VISIT TO SOME ALPINE LAKES

As I had been informed, that an Alpine lake—such a rare phenomenon in the Central Tian-Shan—lay on the heights in the western scarp of the Saikal valley, I sought out this lake on our return. Shortly before the Saikal river enters its gorge-like narrows, a steep ascent of 500 ft. (150 m.) to the west is made over the mountain slope covered with morainic débris, now overgrown with scrub and trees. Thus the heaped-up masses of erratic blocks of an old terminal moraine are reached, which cut off a lateral valley a quarter of a mile wide, running east to west.

Beyond this barrier, in a deep rocky bed,—owing its origin in part to glacial corrasion—lies a deep green mountain tarn, from 1,600 to 2,000 ft. (500—600 m.) long by 1,500 ft. (350 m.) broad, at an altitude of about 8,000 ft. (2,450 m.). By the Kalmuks it is called Nura-nor, and by the Kirghiz Kara-kol. The lacustrine basin is enclosed on the south by a steep mountain wall, overgrown far up with dense dark pine-woods, and on the north side by a similar rampart, but crowned with Alpine meadows and falling with

Digitized by Google

a steep rocky declivity (phyllites), some 200 ft. (60 m.) high, down to the water's edge.

In the west a gully slopes steeply four miles up to the dividing ridge, beyond which lies the Narynkol valley. Through this gully a copious, limpid mountain stream flows between wooded and densely copse-clad banks, tumbling over little cascades down to the lake. Snowy, rocky eminences rise above the encircling ramparts on this side, and beyond the narrow glen of the Saikal river, and are mirrored in the deep-green waters of the lakelet.

It is a somewhat stern, but thoroughly Alpine lacustrine picture, such as is amongst the rarest spectacles to be seen in the Tian-Shan highlands. Through the upland valley, now watered by the streamlet, there formerly descended the glacier, which corraded the lacustrine basin in the easily destructible phyllitic strata, and in its retreat heaped up the moraine wall, after the retreat of the large glacier which once filled the Saikal valley, and which was formerly joined by this lateral glacier. The lake has no visible outlet; but the copious springs, welling up farther down in the bed of the Saikal valley, may probably be fed by its underground discharge. While the shores of the lake are elsewhere steep and rocky, the affluent has developed, on the west side, a small, flat, sandy delta. The high-water marks on the rocky banks stand about eight feet above the surface. That these marks only indicate the high-water level in spring, when the inflow is

Digitized by Google

greater than the outflow, is shown by the traces of the ripplings in the loose sand of the western margin, which stand at the same level and had not yet been obliterated. Hence the lake would appear not to have yet entered on its period of shrinkage. Surmounting the steep slope on the north side, which is clothed with a growth of unusually tall and dense grasses greatly impeding the passage, I climbed up a steep ridge, 10,500 ft. (3,200 m.) high. Here I enjoyed an instructive prospect of the ranges, skirting the Little Musart valley. Just facing me towards the south was the lofty, fine snowpeak, which towers above the dividing ridges between the Narynkol and Bayumkol valleys, and, greatly overtopping its surroundings, serves by its bold formation as the landmark of our Narynkol station.

The altitude of the ridge I ascended coincides with the upper limit of the pine-woods on all the neighbouring mountain slopes. Proceeding north-eastwards a little beneath and along the crest of the range, and then descending a steep incline, I reached the well-wooded Buraty valley, which joins the Little Musart much farther down, and so from thence got back to the Narynkol station.

Meanwhile, I received information of the existence of three other mountain lakes, which, as I was told, lay between the middle Bayumkol and the Kapkak valleys. Such flooded basins, which were formerly so very numerous, but have now become so rare, in the Tian-Shan, present peculiar interest in respect of the history both of

Digitized by Google

glaciation and of valley formation in the Tian-Shan, the two phenomena, to which I had paid special attention during this expedition. I was, therefore, now induced to visit these upland lakes also, and by their means to examine whether the inferences, drawn from my previous observations, were valid.

The middle Bayumkol valley, where it changes its southern for an east-south-eastern course, and a little before its second great basin-shaped enlargement, receives on its (orographical) left bank the copious Ak-kul stream, whose valley at the confluence is about 800 feet wide and densely wooded to a great height by pine-trees. Fluvio-glacial drift-beds extend from its mouth into the main valley in the shape of terraces, which also follow the course of the stream for some miles up its valley. This runs at first south-east, then south and south-west, though the trend of the main axis is south-south-west, following the strike of the granites, which form escarpments along the whole length of the valley (thirteen miles; twenty versts). At the entrance of the valley the granite is stratified and greatly dislocated. After two and a half miles (four versts) the valley begins to contract, and after three and a quarter miles (five versts) has a width of only 160 ft. (50 m.) Here I established my camp in the middle of an extremely dense pine-wood (8,500 ft.; 2,600 m.), and ascended the valley, near the head of which stands Lake Ak-kul. The bed of the river slopes rapidly, and both banks, throughout the whole

Digitized by Google

length of its course, abound in copious springs, more numerous than I had yet noticed in any Tian-Shan valley. To these springs, rising in the dislocated granites and not to the overflow from the lake, the river is indebted for its great volume of water. The granite escarpments are covered up to a considerable height with drift, on which flourish much timber, brush, and rich Alpine grass. Glacial polishing may be observed high up the rocky escarpments. Where the valley again acquires a considerable expansion it is blocked across its entire breadth by an enormous wall of morainic blocks, whose level top coincides with the limit of forest vegetation (about 10,000 ft.; 3,000 m.). Beyond this barrier the bed of the valley is but slightly inclined. Here the traveller passes continually over ground strewn with drift, between old verdant lateral moraines, and reaches the swampy green floors of basin-shaped expanses, which were formerly filled by Alpine lakes. The profile of the valley and the relief of the deposits on its bed are typical of a valley, shaped by glacial agency. Of the moraine ridges, which lie between the several lacustrine basins and formerly intersected them, only a few slight remains are still visible.

At last I reached the foot of a huge morainic rampart of blocks, which bars the valley and extends for a stretch of about one and a quarter miles (two versts) along it. Immediately beyond lies the lake Ak-kul, flooding the bed of a former glacier, which was derived from the cirque-like heads (Kare) of the two feeders, now free from

Digitized by Google

ice, one flowing from the south-east, the other from the south-west.

Shortly before reaching the lake basin these valleys cease to fall at a steep incline, and uniting, open into the valley at the level of the bed of the lake. The course of the now verdant old ground-moraines in the two feeders, as well as the lines of the lateral moraines, may still be quite clearly followed. An irregular form was imparted to the lake, partly by the bending of the valley just below the junction of the two feeders, and partly from the great quantity of drift added to the terminal moraine by an extensive glacier, which formerly joined it from the east, so that here the masses of erratic blocks, projecting like bluffs, were thrust forward into the basin. Nevertheless, its average length may be estimated at 1,300 ft. (400 m.), and its breadth at 600 ft. It stands 11,000 ft. (3,350 m.) above sea-level.

The quantities of detritus, brought down in the streams from the head valleys, have already filled up the lake basin to such an extent, that not more than half of it is now under water, and that is only shallow. From the quantity of argillaceous particles held in solution, the water has acquired a milky grey-white colour, whence its name Ak-kul, "White Lake." The history of this lake, which has now entered on the last phase of its existence, is typical of that of hundreds of other much more extensive bodies of water formerly enclosed in the Tian-Shan valleys. During the spring months the basin, as the Kirghiz informed

Digitized by Google

me, appears to be still annually flooded twelve or sixteen feet above its present level by the melting of the winter snows. I found a confirmation of this report in the blocks of the morainic wall on the shores of the lake, which were coated up to that level with a fine grey-white clay sediment, that was found to be still soft. The overflow of the lake finds an outlet under the wall of erratic blocks, at the outer base of which it reappears as a small rivulet. Of the feeders of the Ak-kul, that on the east rises on a ridge, over which a pass leads to the Ashu-tyr valley; the western on a similar ridge, by crossing which the Kapkak valley is reached.

In a valley, intervening between the Ak-kul and the Ashu-tyr, lies the lake Yashik-kul, which I did not visit. I was, however, informed by the Kirghiz that it had been more filled up by deposits than the Ak-kul.

On the other hand, its full volume of water is still preserved by the lake Kara-kul-say, lying in the uppermost basin of the very important lateral Kara-kul-say valley, which joins the Kapkak from the south-east. This lateral valley is almost as large as the main valley, and nourishes a like wealth of Alpine meadows and woodlands. I reached it by penetrating west-south-westwards into the Yar-kasn-say, a side-valley of the Ak-kul; then, turning near its head to the west-north-west and surmounting a ridge 12,000 ft. (3,700 m.) high, the upper course of the Kara-kul-say was reached at an altitude of 7,700 ft. (2,350 m.). Profile

Digitized by Google

and general relief of this fine Alpine valley are likewise evidence of its having been shaped by glacial agency. A series of now vanished lakes may still be traced along its course, all of them owing their origin and their disappearance to the same causes as Lake Ak-kul. The valley has similarly been excavated in the granitic rocks, in which intruding diabase may here be observed. The lake is dammed by a wall of boulder drift over 300 ft. high, and its water has a deep greenish-black colour, which justifies its name of Kara-kul, "Black Lake." The basin is 2,800 ft. (850 m.) long by 1,300 ft. (400 m.) broad, and stands at a level of about 11,000 ft. (3,400 m.). Its regular oval form is varied only by two small inlets. The lake receives its chief affluent from a valley in the south-south-west, whence a now ice-free cirque or "Kar," enclosed by high rugged walls, once discharged a very considerable glacier, by which the flat lacustrine basin has been corraded in trough form between the granite walls. The operation was furthered by lateral glaciers, joining the main glacier from transverse valleys. Judging from the watermarks on the shore, the spring level lies about twelve to sixteen feet above that of the autumn season. The filling-in process has not yet made much progress, and the sheet of water is still of imposing extent. The lake, which, as I was informed, teems with fish, is not without romantic charm, but lacks the animating grace of woodlands and of conspicuous mountain forms in its environment.

Digitized by Google

Here, also, the overflow finds an outlet beneath the masses of morainic drift damming up the lake.

While I was occupied with the investigation of these lakes I sent the Tyrolese, Kostner, to the Mukur-inutu valleys, in order to replace the photographic views, which had been taken there the previous year and afterwards lost in the Musart river. He had also instructions to keep an open eye again for the fossiliferous beds of that district. Although these limestones, so rich in fossils, had been highly metamorphosed by direct contact with the granites, and the fossils crushed beyond recognition—(see my previous reports, p. 16 *et seq.*) he had nevertheless the good luck to discover a bed, from which we were able to extract a lower carboniferous fauna, that could still be identified.

Digitized by Google

CHAPTER XXIII

THE DONDUKOL VALLEY AND THE NORTHERN MUSART VALLEY AGAIN

CONTINUOUS fine weather promising still to favour my explorations, I now turned to the important but hitherto unknown lateral valleys of the northern Great Musart river. It was of great importance for the completion of my topographic work, that the connection should be ascertained between these valleys and the huge glaciated ranges, branching off eastwards from Mount Nicholas Mikhailovich. My attention had already, in the previous year, been drawn (see p. 88, 85) to the Dondukol valley, which joins the Great Musart four and a half miles (seven versts) above its outlet into the Tekes plain, ten miles (fifteen versts) above its confluence with the Tekes. I was attracted not only by the picturesque charm of the wooded mountains encircling the confluence, but mainly by the large volume of water, sent by its overflow down to the Musart river. As this stream is almost as copious as the main river, the inference was, that a large glacier must be harboured in the valley, the existence of which was still unknown.

From my headquarters in the Narynkol Staniza,

Digitized by Google

an easy day's march (about twenty-six miles; forty versts) brought me to the entrance of the Dondukol valley, from whose broad opening verdant fluvio-glacial terraces of great extent stretch far out, and meet similar deposits, drifted from the main valley, at an obtuse angle; retrogressive formation of longitudinal terraces is the consequence. The choicest grazing-grounds of the Kalmuks are found on the broad levels of these terraces. Just beyond its debouchure (about 6,700 ft.; 2,050 m.) the valley contracts to 200 ft. 60 m.), and is overgrown with very dense pine-woods, reaching far up the mountain slopes. Terraces of glacial drift accompany its course for a few miles, to where it narrows to a cañon thirty to forty, and in places only twenty feet wide. The passage of this cañon, which has a length of four miles (six versts), is difficult, and possible only at this advanced season of the year. Even now in the late autumn a considerable stream of swirling water still rushed through this gloomy cañon, which is strewn with rock-fragments, and interrupted by a waterfall disposed in three stages, each fifty to sixty feet high. Here, as in many other places, one has to force one's way through a wilderness of forest and boulders, over terraces in the rocky ramparts. In summer great volumes of water are discharged through the narrows, as is shown by the marks on the cliffs fourteen feet above the autumn level. Then the Kalmuks, in order to reach the excellent pastures on the upper course of the Dondukol, are obliged to

Digitized by Google

make a long round with their flocks through the Mukur-mutu valleys and the Maralty valley, crossing two lofty ridges on the way. The Kalmuk hunters also choose this way in the early part of the year, when they go to stalk the Maral-deer, which is so eagerly sought for the sake of its costly antlers, and still abounds in the dense woods of the Dondukol valley.

The axis of the valley has a general southerly trend, but is deflected both to the east and west, and at its head decidedly to the east. The mountain formations consist for the most part of an extensive horizon of green phyllitic schists of diverse character, often resembling grauwacke schists, often Aphanites. Between them occur zones of crystalline limestones, beyond which immediately follow gneiss and gneiss-granite, then granites of diverse structure, and limestones, more or less crystallised or else transformed to schists, also true marbles, a series, between which diabasic rocks are found embedded. The whole stratified system has a nearly east to west strike, varied with slight deviations to the south or north, with a very steep dip of 60—70°. Hence the ascent of a lofty summit by a long track over a crest, gave me a welcome opportunity to follow more accurately the changes in the strata along this trend, and to collect specimens of the whole series. The shingle, however, in the mountain stream already pointed in the middle course of the valley more and more to the fact, that in this, as in the other transverse northern valleys, the highest

Digitized by Google

range, enclosing the head of the valley, is composed exclusively of sedimentary rocks: more or less metamorphosed clay schists, and limestones, together with marble.

Scarcely has this romantic gorge again broadened out, when the valley thus formed is blocked by an enormous land-slip, which fills it up for a length of over a mile, to a height of over 300 ft. above the level of the valley (about 7,800 ft.; 2,340 m.). The débris consists exclusively of green phyllitic rock and of diabase, which have crashed down from both sides, but especially from the left escarpment. A track of difficult access for pack-animals leads over this tremendous bar, beyond which the river was once dammed up in a lake one and a quarter miles long, with an average breadth of 500 ft. (150 m.), until it succeeded in finding an outlet under the barrier. Presumably it had regained its old bed. For nearly its whole course the slopes of the valley are overgrown with the finest, densest, and most continuous pine-woods, that I have anywhere seen in the Tian-Shan. Moreover, owing to the above-mentioned steep disposition of the strata, the crests of the ranges along its banks are much torn, deeply indented, and carved into a series of rugged peaks, diversely outlined and adorned with glaciers, even the slopes themselves often appearing broken up in a chaos of pinnacles and cliffs. Lastly, the copious, limpid mountain stream, the smiling Alpine meads, the numerous clusters of tall bushy growths, all lend a special charm to this valley, which thus

Digitized by Google

ranks amongst the most picturesque in the Tian-Shan uplands.

Wherever the valley broadens out, unmistakable traces have been preserved of its former extensive glaciation in the relief of its surface and in the masses of old morainic drift, reaching high up along the escarpments. It is joined only by one considerable lateral affluent, and that on the (orographic) right bank. About the confluence, also, there occur high verdant ridges of old morainic drift. But all the other affluents of the main stream descend, not from valleys in the true sense of the word, but from upland ravines, densely wooded.

Some seventeen miles (twenty-six versts) farther up, the valley is again blocked by an old terminal moraine about a mile wide, through which the river forces its way in a cañon-like defile. Beyond this moraine the valley, rising generally with a very slight incline, is nothing more than a flat bed of glacial drift from 600 to 1,000 ft. (200—300 m.), and at its head from 1,000 to 1,300 ft. (300—400 m.) wide. Here the left scarp is rent into a number of rugged summits with fine intervening glaciers. Of these peaks, the highest closes with its west flank the Uertenty valley, ascending from the north-west (see pp. 15, 17, 247).

After about twenty-three miles (thirty-five versts) we reached the foot of the range, which closes the valley and forms a semicircular rampart, rising over 6,500 ft. (2,000 m.) above its level (about 9,350 ft.; 2,850 m.), and is completely buried

Digitized by Google

under nevé and ice. From its slopes descend steep glaciers directly to the flat, gravelly bed of the valley, which expands in the form of a cirque. The head of the valley shows a great resemblance to that of the Bayumkol, ramifying, like it, into two glacier valleys, one of which trends east, the other west, the western being the longer, the eastern the richer in varied forms, just as in the Bayumkol. The length of the western glacier, which descends in a narrow, moderately inclined valley, I estimate at from three to four miles. Its head is closed by a flat nevé ridge with a saddle, the direction of which points towards the easterly, uppermost Saikal valley (*vide* p. 252). All along its northern edge this glacier is skirted by a mountain wall, which is clothed in verdure nearly up to its rugged crest, while along its foot stretches a belt of brushwood interspersed with pine-trees. Still more surprising is the height, to which the forest reaches along the ice of the middle glacier. Here, immediately in front of the rugged glacial walls, a ridge, completely buried under morainic drift, attains some 1,000 ft. (300 m.) above the level of the valley. This ridge is covered with grass and scrub right to the top, and up to two-thirds of its height with pine-forest, which consequently penetrates several hundred feet up into the zone of ice. The grandest object at the head of the valley is the branching eastern glacier. Here stands a group of extremely rugged and richly glaciated rocky peaks, with some snowy summits, flanking a deeply

Digitized by Google

notched gap, over which access is afforded to the head of the Khamer-davan (*vide* p. 86), the next great tributary of the Musart valley. This valley owes its name to a deep col, which is flanked by a nose-shaped, jagged crag (Khamer-davan = "Nose pass"). The rampart closing the Dondukol valley does not belong to the main watershed, but, like that of the Saikal valley, forms a part of the northern bordering range of the great glacier valley, trending east from Mount Nicholas Mikailovich.

In order to get a clear grasp of all these relations, and especially of the course of the last-mentioned valley, I ascended a peak (about 13,000 ft.; 4,000 m.), situated in the range on the right bank of the Dondukol. It was reached over a verdant pass (about 11,000 ft.; 3,300 m.), which gives access to the Great Musart valley. One might gain this valley near the second Chinese post. I have already mentioned that, by making a day's excursion along this crest, I found an opportunity of collecting specimens of the whole series of strata in the eastern range skirting the valley. Moreover, from this elevation, we were able to secure telephotographic views of the chain, branching eastward from Mount Nicholas Mikhailovich, and of Khan-Tengri, towering up beyond it. But the finest part of the prospect and the most important section of the highlands photographed, were the superb, many-peaked ranges east of the Musart pass, which encircle the upper Ak-su and Agiass valleys.

My intention was to ascend yet another peak

Digitized by Google

in the western scarp of the valley, in order from the nearest point to sketch the connection of the Dondukol, Uertenty and Saikal valleys. But the verdant parts of the steep slope were found to be already frozen so hard, that we could no longer secure a footing with our worn-out mountain boots, and the climbing-irons were not at hand. Moreover, despite the sunny hours of daylight, the frost had grown so intense that we were no longer able, in spite of all our wrappings, to keep ourselves warm at night in our thin mountain tents. It was now the end of October, and further residence in the upland valleys was growing daily more impossible. For these reasons I had, to my great regret, to abandon the exploration of the next large lateral valley, the Khamer-davan, as well as the proposed visit to the large glacier valley, branching east from Mount Nicholas Mikhailovich, both of which were very important for the completion of the observations hitherto carried out. Many things, which might have been placed beyond doubt by that visit, had consequently to remain mere assumptions based on probabilities. I now confined myself to a ride up the Great Musart valley as far as the confluence of the Khamer-davan, because a sketch-survey of this tract was needed for the completion of my surveys, and because I wanted to follow up some geological observations, interrupted the previous year.

From the mouth of the Khamer-davan (about 8,000 ft.; 2,400 m.) project some very extensive moraines, whose form has been very well pre-

Digitized by Google

served. Their junction with an old terminal moraine of the main glacier, which is several miles wide (see p. 86), lends much variety to the relief of the valley-bottom. The ranges bounding the Khamar-davan, ice-clad even from the entrance of the valley, as well as the volume of the stream, still copious at this late and dry season of the year, point to a considerable reservoir of glacier ice and nevé, still stored up in this valley. Indeed, the Kalmuks, who visit it with their flocks in summer, spoke to me of extensive glaciers.

Digitized by Google

CHAPTER XXIV

OVER THE TEMURLIK-TAU TO KULJA

AND thus my explorations in the highlands were brought to a close. My next business was to pack up the collections in Narynkol and forward them over the San-tash pass, before the snows had made it impassable. I proposed to return by way of Kulja, as I wanted to revisit and exploit the fossiliferous limestone beds, which I had discovered ten years before in the Temurlik-Tau, in the Khonokhai valley, the source of the Jijen. I also hoped, on my way down the Tekes valley, to be able to secure another comprehensive tele-panoramic view of the whole of the gigantic Tian-Shan ranges, stretching between Khan-Tengri and the Karagai-tash pass. Unfortunately, however, on this route the fickle weather played me false. The highlands were mostly veiled in autumn fogs, though 'tis true they arrived this year a month later than usual. Hence but little could be done. As the mists occasionally lifted, I was once more struck by the mighty forms of the peaks, towering up in this little-known section of the great range, and at the profusion of nevé and glaciers. In this respect all one's dreams are surpassed especially by the ramparts of the two great longitudinal

Digitized by Google

Agiass and Kok-su valleys, which divide the mountain masses along nearly the whole of this stretch, and only in their lower course, suddenly bending round, take the direction of the transverse valleys and debouche into the Tekes. Here a broad, unploughed field still lies open to mountain exploration. No doubt the above-mentioned large valleys have in recent years been sometimes visited by English travellers, but exclusively as hunting-grounds, so that geography has profited nothing by these expeditions.

During my way down the Tekes for about seventy miles my attention was also drawn to the contours of the large lakes, which formerly stretched along the northern slopes of the main chain. But I will reserve this subject for my detailed report.

As I drew near the point, where the Jijen river escapes from the mountains, I was surprised at the great alterations, made in the former modest little Sumba lamasery. The simple temple buildings, I had visited ten years previously, had disappeared. In their place, but a little higher up the mountain side, the monks had erected a very extensive establishment of several hundred neat dwellings, where from two to three hundred lamas are now comfortably housed. The monotonous arrangement of these block-houses is broken by agricultural buildings, huge towering hayricks, etc. In their midst rises a grand and spacious temple, surrounded by large courts, flanked by smaller shrines and elegant pavilions. The whole group, erected by Chinese workmen, is splendid, har-

Digitized by Google

moniously disposed and effective, carefully and tastefully carried out and painted in bright but not glaring colours—assuredly one of the most beautiful temples in the west of China. Everything is built of wood, except the platforms, on which stand the several temple structures and the monumental gates of the inner temple court, which are of burnt brick. Extensive woods were cleared away to provide the material for this spacious lamasery. The aged Da-Lama, who had given me such a hospitable welcome ten years before, had since died ; but his successor also showed himself obliging and considerate. He allowed me to photograph the temple inside and outside, and even showed me round everywhere himself.

Unfortunately, the weather had turned quite bad. Winter had suddenly set in in all its severity, with heavy snowfalls and intense cold. The crossing of the Temurlik passes was no longer an easy matter. When I left the friendly lamasery (about 6,400 ft. ; 1,950 m.) on November 5th, in deep snow, and turned to the mountains, I almost gave up the hope of being able to collect any more fossils. Nevertheless, against all expectation, I had the good luck to secure a rich lower carboniferous fauna in the Khonokhai valley. Certainly the work was much impeded by the deep fresh snow, and under more favourable conditions the spoils would assuredly have been far richer.

The Khonokhai pass, that I wanted to cross, was already blocked by snow, as were also the other

Digitized by Google

passes. The far longer way through the defiles of the Shateh pass (about 10,000 ft.; 3,000 m.) was the only one now open to me. It was traversed amid incessant snowstorms under great hardships. To my regret I was no longer able to derive much profit from a district, which is interesting both geologically and for its charming scenery, and after two days' plodding, was fain to be satisfied with the knowledge, that my caravan had safely reached the Kalmuk station of Ukurchy (about 4,600 ft.; 1,400 m.), at the north foot of the highlands. Thence we made our way to Kainak (about 2,500 ft.; 750 m.), on the Ili plain, and on November 9th I entered Kulja. As a great part of my collections was still at Przhevalsk, where they would have to be re-packed before being sent on, there was nothing for it but to re-cross the mountains (Ketmen-Tau) from Jarkent, although the snows and ice had made the road almost impassable. Thanks solely to the intervention of Mr. Smirnoff, at the head of the Jarkent district, who summoned the Kirghiz to my aid, I was able to get through, and entered Tashkent at the beginning of December.

Digitized by Google

CHAPTER XXV

SUMMARY

When I cast a glance back on the results of this long expedition, full of cares and hardships, I feel myself justified in declaring that it has not been carried out without benefit to science. When all the topographical surveys, made during the journey have been brought together in a single cartographic picture, the notions, hitherto entertained regarding the structure of the Central Tian-Shan, will be modified and completed in many respects.

By the description, undertaken by Herr Keidel of the geological structure of the regions traversed by us, the new facts, already disclosed in this report, will be added to and more fully elucidated, while the knowledge, hitherto current of the geotectonic relations of these gigantic highlands, will in many points be supplemented, in others corrected.

The foundation for this description will be laid by the paleontological and petrographical collections, secured during the course of the expedition. Of these the former are certainly the richest, that have ever been brought hither from this part of Central Asia, while the petro-

Digitized by Google

graphical ones are scarcely second to them in importance. By both, fresh light will be shed on the stratigraphical system of Central Asia.

Until these rich materials have been examined and determined by competent experts, it would be rash to draw conclusions from the facts, recorded in this preliminary report and from other data, not incorporated therein. Only on one point my scientific conviction is already settled once for all—namely, that for the Tian-Shan also an ice age has to be accepted. Much, that in the present report could merely be suggested in support of this view, will be more fully developed in another to follow later, where overwhelming evidence will be adduced in favour of my assumption. Certainly, the last glacial period in the Tian-Shan, which for the present can alone be spoken of as clearly established, may have taken a different course from those of Europe, in accordance with the particular phenomena, preceding the close of the ice age in Central Asia, above all as regards the distribution of land and water and other specially Central Asiatic conditions. But as to whether, as in other highland regions, here also several glacial periods succeeded each other a final decision will not be possible until the observed facts have been submitted to a more sifting scrutiny. The objection might even now be raised to my assumption, that in the broad tracts stretching along the foot of the Central Asiatic highlands, no traces are discoverable of a former ice-cap—such as are found in such abundance in Europe and America. I

Digitized by Google

should therefore like at once to point out, that in regions, where abrasion, destruction and the removal of their products have operated to such an extraordinary extent as here, and where, moreover, owing to the most violent thermal contrasts and other climatic influences, which cannot here be further dwelt upon, the demolition and removal of the original surface and its redistribution have so far advanced, traces of glaciation naturally cannot have been preserved to the same extent as in Europe and America. Nevertheless, they are by no means lacking, as I shall show by the coincidence of my own observations. And as such evidence has not hitherto been seriously sought after by any one, it is reasonable to suppose that it will yet be found, both in far greater abundance and spread over a much wider area.

During this expedition photography was placed at the service of exploration to quite a pre-eminent extent, in order as far as possible to secure pictorial evidence and demonstration of the facts observed.

Our operations were conducted with three cameras of different construction and dimensions, as well as with different plates, adapted to the varying conditions. Profitable use was made of the telephotographic process, which, aided by the most recent appliances, gave excellent results, and must be regarded as an indispensable aid to travellers in highland regions of difficult access. During the expedition over two thousand photo-

Digitized by Google

graphs were taken, whose reproduction will reveal a hitherto unknown highland world.

Less rich than the paleontological is the botanical collection, to the gathering of which a systematic method could not be applied. It was carried out only to such an extent, as time and our resources permitted consistently with the work, that had to be devoted to the other matters of primary importance, included in our programme. In mountain expeditions, which in any case make such severe claims on the traveller's time and strength, in which the state of the weather also is frequently most adverse and, owing to the constant hurry, required to secure objects very difficult of attainment, the most promising localities can often be exploited only in a very cursory way, or even not at all; here, at most, only a little of the flora can be snatched up in all haste and any hope of systematic botanising must, from the first, be given up. Nevertheless, even the botanic collection is not unimportant and contains, besides numerous specimens of the upland flora, a somewhat rich assortment of the early spring flora of the South Tian-Shan steppes and deserts.

Still less favourable were the conditions for gathering zoological collections, during a mountain expedition, whose aims were directed to quite another domain. Still, we did not altogether neglect this branch of science. The specimens collected are numerous, and many of them of high interest.

During the whole expedition, records were taken

Digitized by Google

twice a day of atmospheric pressure, temperature, and humidity, the barometric pressure being taken simultaneously with three aneroids, whose condition was compared at intervals of one or two days with the boiling-point thermometer. For determining the temperature relations of the atmosphere, maximum and minimum thermometers were employed. Moreover, observations were taken of insolation, wind-pressure and cloud-formation, as far as possible. These observations, when all are worked out, will thus present a clear picture of the climatic relations in the regions traversed by us, and at the same time furnish the cartographers with the necessary data for fixing several hundred points.

For whatever results may have been secured in the difficult regions traversed by the expedition, I am, to quite an exceptional degree, indebted to the favour and support received from the directors of the Imperial Russian Geographical Society. I therefore here tender my respectful thanks to the illustrious first president of this association, which has rendered such signal services to the work of exploration in Central Asia, His Imperial Highness the Grand Duke Nicholas Mikhailovich, who showed such great sympathy and encouragement towards my expedition. My most sincere thanks are also offered to the acting-president of the same corporation, the distinguished first explorer of the Tian-Shan, His Excellency P. P. Semenoff, for his excellent advice, and for the official passport (*Atkrytylist*) of the society, as

Digitized by Google

well as for special permissions on behalf of the expedition, procured from the highest Imperial Russian officials. My warmest acknowledgments are likewise due to the chief secretary of the society, Professor Grigorieff, for placing at my disposal the rich and valuable Russian literature on the Tian-Shan and for many other friendly services.

My undertaking also enjoyed the special goodwill of His Excellency Lieutenant-General N. I. Ivanoff, shown by assigning me a Kossack escort, by instructing the officials under his jurisdiction to lend me every assistance, and by many other favours, for all of which I here tender him my liveliest thanks. I feel specially grateful to General von Stubendorf, head of the topographic section of the General Staff, who kindly provided me with the necessary maps; to Mr. N. F. Petrovsky, Imperial Russian Consul-General in Kashgar, for the furtherance of my undertaking in divers and sundry ways; to the district magistrate in Osh, Colonel Saizeff, for his zealous and kindly co-operation; to His Excellency Herr Giers, late Russian envoy in Munich, for procuring the introduction of my equipment into Russia duty-free. If I was successful in my photographic operations, I am much indebted for this to my friend, Cavaliere Vittorio Sella of Biella, who not only placed his incomparable experience at my disposal, providing me with his excellent advice before I started, but also took upon himself the enormous labour of working out my great collection of

Digitized by Google

negatives. For this most unselfish labour I here tender him my heartiest thanks. I feel indebted to many other persons, without whose help it would have been impossible, to overcome the incidental difficulties of the undertaking, who, without being actually named, may here accept the assurance of my lasting gratitude.

Digitized by Google

NOTES CONCERNING THE MAP

THE accompanying map, as may be seen from its title, does not profess to give a complete and accurate representation of the physical features of the Central Tian-Shan. In order to enable the reader to follow the course of the Expedition, a sketch-map had to be provided before the surveys and observations of positions and heights, made during our travels, could all be worked out and embodied in a complete map, which, on account of the great extent of the region traversed and the quantity of topographical details collected, will need a good deal of time to elaborate. However, the principal geographical results of the Expedition have been incorporated in the sketch-map, though only in a provisional fashion, and the most cursory comparison with any of the hitherto published maps will reveal essential differences in the main features of the Tian-Shan.

As many hundreds of barometrical observations of altitude, made during the Expedition, have yet to be accurately collated, the figures relative to these points could be inserted only in round numbers, which do not claim to be absolutely correct. At most the relative heights, as compared

Digitized by Google

with one another, may be accepted as fairly accurate. On such a small scale it was impossible to insert all the places, passes, etc., or the names of all the rivers and streams, without impairing the clearness of the map, in which only those places will be found, which were visited by the Expedition or lay near its route. Those glaciers, which were crossed and surveyed by the Expedition, are all delineated; of the remainder, only those that could be well seen from our route are inserted. Thus, the glaciers of the Naryn district, and those of the extensive region, drained by the great river-systems of the Agiass and the Kok-su, are not represented, although the higher portions of the Agiass and Kok-su groups are covered with a continuous mantle of nevé, from which large primary glaciers descend to the valleys. The hydrographic system, as shown in this map, may, in spite of its somewhat cursory rendering, be taken as tolerably accurate.

As regards the spelling of names, I have not attempted a fastidious rendering, by means of unfamiliar letters or signs, of intermediate sounds, not known to the English language, such as Tiën-Shan, in lieu of Tian-Shan, since such subtilties can only interest the linguist or etymologist. It has been my aim to give the simplest possible phonetic equivalents of the names of places in the Tian-Shan, most of them of Turkish origin, but I am well aware that, in the hurry of preparation, some inconsistencies may have, here and there, occurred. Having been at the greatest pains to

Digitized by Google

ascertain the true, current names of localities, and having visited most of them repeatedly and thoroughly, I think my nomenclature has a claim to authority.

Places marked with o are not always villages, but in many cases pasturages, which are regularly visited, at certain seasons, by the Kirghiz herdsmen. The sign ¤ stands for places, where the Chinese government maintains military posts. The routes followed by the Expedition are denoted by red lines. Further details were precluded by the small scale of the map.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

INDEX

Abdul-kia or Alep-turga, 115
Achailo pass, 218
— torrent, the, 217
Achik-tash valley, the, 62
Adyr-tyr glacier, the, peaks to the south of, 41
— valley, the, 60, 62, 189; wealth of glaciers and mountains in, 60; geological formation of, 61; and *vide* Mushketoff glacier
Agiass river, the, 88
— valley, the, 273
Aire river, the, 144
Aiktyk valley, 112
Ak-bel plateau, the, 177
— valley, the, glacier pass in, 168
Ak-chiu, Herr Keidel collects fossil plants at, 109
Ak-kia, 116
Ak-kul lake and river, 257, 258
— valley, expansion at the mouth of the, 23
Ak-shiriak chain of mountains, the, 177, 178
Ak-su, town, 102, 126, 137
— river and valley, the, 150, 157, 234
Ak-tala, 119
Ak-topa valley, the, 94
Alagyr valley, 135
Alai-aigyr valley, moraine at the mouth of, 23, 27, 249
Alexander mountains, excursion of Herren Pfann and Keidel to, 8
Almassy, Dr. G. von, suggestion by, as to the waters of the Sary-jass, 240
Alpine lakes, a visit to some, 254-262
Altyn-Artysh villages, 103, 105, 112; destruction of, by earthquakes, 103
Angara series, fossil plants of the, 109
Apatalkan pass and valley, the, 114
Argu basin, the, terraces in, 105
Arkogak basin, the, the bed of 106
— lake, 105
"Artysh strata, the," 103, 104; seismic movement in, 104; villages, 104
Ashu-tyr pass, 38
— valley, the, 26, 36, 38, 260; view of Khan-Tengri from near the mouth of, 26; length of, 36
Ayak-Sugun, 108

Bai, town, 126, 127, 128
Balter-Yailak valley, 167, 168
Bash-chakma, 124
Bash-kara-bulak valley, the, forms of a vanished glacial epoch in, 13
Bash-ogly-tagh chain, the, 10, 12
Bash-Sugun pastures, the, 106; fossils found in, 107; a second

Digitized by Google

excursion to, 109; carboniferous Permian deposits in, 110, 112
Bayumkol glaciers, the, 27, 28, 33, 34, 80, 245; the formation of, 80; the eastern glacier, 250
— pass, 80, 187
— valley, the, 19-35; the mouth of, 22, 24; geological profile of, 25, 26; crystalline rocks in, 25; the middle course of the valley, 27; climatic conditions, 29, 30; glacier region of, 33, 34; bad weather in, 35; a second visit to, 79; the ridge between the Bayumkol and Karakol valleys, 81; a third visit to, 245; the middle valley, 257
Bedel pass, the, 118, 159, 166, 173; information on the route through, 170
— river, 174 *et seq.*
— valley, the, 144, 171, 173; blue-green slates in the limestones in, 171
Bogdanovich, M., 107; formations named by him, 97; his views on the geological position of the "Artysh strata," 104; fossils found by him, 104, 105
Bom-khotan, geological formation near, 133
Borkoldai chain, the, 176; the crystalline zone in, 161
"Bos-aidyr chain," the, 113, 116, 118
Bos-tagh range, the, 138, 149, 150
Botanic collection, the, made by the expedition, 279
Bulung-turuk, 122
Buraty valley, the, 256
Busai-tash pass, the, 132
"Catherine Peak," 176
Chadan-Ta, 101
Chagash-gumbes, the Aul of, 116
Chakh-chi, 127
Chakmak, Yakub Beg's fortified post at, 105
Chalkody-su valley, the, 13
Chalmaty valley, the, 173
Chandar Aul, the, 147
Chapta-khanne, 135
Chatyr-kul lake, 179
Chiran-toka valley, the, 98
Cholok-su valley, 135
Chon-jar valley, the, 166
Chorlok river, the, 147
Chul-Tau, the, 101, 127
Climate in the Central Tian-Shan region, records taken of, 29, 30, 69, 280

Darvasse-su valley, the, 158
Déchy, M. von, help afforded by, 4; hospitality of, 6
Denge-davan pass, the, 123
Dondukol river, the, 83, 85
— valley, the, 15, 247, 252, 263-271; glaciers in, 268
Dungaretme pass, the, 169

Earthquake, a severe, 71, 161
Eski, 109

Friedrichsen, Dr., 8, 37, 38

Gess valley, the, 109
Giers, Herr, 281
Grigorieff, Professor, help afforded by, 2, 281

Hedin, Sven, 114, 120, 121, 146

Ignatieff, I. W., expedition of, to the glaciers of the Central Tian-Shan, 3, 80; name given by him to the Karakol valley,

Digitized by Google

37; his estimate of the extent of the Semenoff glacier, 43; of the Inylchek glacier, 67; of the Mushketoff glacier, 189; his notes on the geology of the Great Musart route, 82
Ili plain, the, 275
Ilovaisky, Prof., help rendered by, 7
Inylchek glacier, the, 41, 60-75, 182, 193; extent of, 67; attitude of, at its lower end, 72; the chain skirting it, 41, 52, 66, 202, 205; exploration of, 196-208; its total length, 210
— river, the, 67, 238
— valley, the, 194; the south border range of, 41, 52, 66, 205; the mountain chain on the north side of, 64; dry atmosphere of, 69; description of, 68-70, 241-243; climatic peculiarities of, 75; a superb range between it and the Kayndy valley, 218
Ionoff, Lieutenant-General, 8
Ishigart-Tau, the, 143, 174, 238
Ishtyk pass, the, 176, 180
Ishtyk-su, the, 143, 174; the headwater region of, 178
Issyk-kul lake, the, 8, 180, 182, 183
Ivanoff, Lieutenant-General N. I., friendly reception accorded by, 7, 281

JAI-TEVE, the Kirghiz settlement of, 114
Jam-kuluk village, 129
Jam-tama valley, the, 194
Janart pass, 142
— valley, the, 140, 141, 143, 144; its richness in grass and forests, 165
Jan-kasnak valley, the, 134
Jin-jilga valley, the, 96
Jiparlik glacier, the, 89; end of, 90; its length, 91
Jitim-Tau, the, 179

KAICHE pass, the, 159
— valley, the, 138, 143, 144
Kainak, 275
Kaldy-Yailak plain, the, 108
Kali-agach valley, the, 128
Kapkak pass, the, 76, 186, 244
— river, the, 77
— valley, the, 186; special features of, 77
Kapsalyan river, the, 128, 129
— valley, the, 129, 132
Kapyl-Tau mountains, the, 12
Kara-archa gorge, 230 *et seq.*
— pass, the, 227, 228, 229
— torrent, the, 229
Karabag plain, the, 134, 135
Kara-bel pass, the, 112, 228
— valleys, the, 225
Kara-bulak, 116
Kara-bulung, 122
Kara-bury pass, the, 152
Kara-gat valley, the, 150
Kara-jil, 113
Karakol glacier, the northern, 38; coating of moraine débris over the southern, 136
Kara-kol lake, the, 254
— valley, the, 37, 173
Kara-kul-say lake, the, 78, 260, 261
— valley, the, 78, 260, 261
Kara-say, the, headwater region of, 177, 178, 179
Kara-turuk gorge, the, 121
Karkara, ancient lake floor of, 10, 183, 185
Karmulde, 174
Kasalai valley, the, 157
Kash-bulak valley, the, 94
Kashgar town, 102, 109, 111, 112; earthquakes in, 104

Digitized by Google

Kashgar-daria valley, the, loess deposits in, 109
Kashka-su valley, the, 42
Kashka-tyr pass, the, 185
Kasnak-su, river, 128, 134
Kaulbars, A. W. von, explorations of, 3; his notes on the topography of the Musart pass, 82; his appreciation of the significance of the Borkoldai chain, 176
Kayndy glacier, the, 221, 222, 223
— river, the, 219, 220, 238
— valley, the, 73, 204, 205, 219, 220, 222, 223, 236; survey of, 236; ranges skirting, 220, 225, 237; signification of name, 220
Keidel, Herr Hans, 111, 120; joins the expedition, 4; his share in the report of the expedition, 5; he starts from Munich, 6; makes an excursion to the Alexander mountains, 8; collects some fauna, 11, 152; investigates the tertiary formation of the Tekes plain, 14; takes the geological profile of the Bayumkol valley, 25, 26; fossils discovered by, 38; investigates the geological structure of the range surrounding the Sary-jass, 42; his researches in the lower Inylchek valley, 73; collects specimens from the Musart valley, 92; his collecting zeal, 102; his discoveries in the Tegermen basin, 106; investigates the loess deposits in the Kashgar-daria valley, 109; fauna collected by him in the Ot-bashi-tagh region, 125; his attempt to penetrate the Kapsalyan valley, 132; carboniferous fauna found by him in the Kok-shaal valley, 142; Devonian fossils found by him, 160; collects fauna in the Kok-jar valley, 185; triangulates above the Semenoff glacier, 186; in the Kayndy valley, 221; his description of the geological structure of the Central Tian-Shan, 276
Kenem-begu valley, the, 23
Kepek-chai valley, the, 131
Kerege-tash pass, the, 181
Ketmen-Tau heights, 11
Khalyk-Tau, the, 88, 97, 121; first exploration of, 126; information of it doubtful, 127; exploration of its valleys, 128-135
Khamer-davan valley, the, 186, 269, 270, 271
Khan-Tengri, the position of, 15, 17, 52, 53, 58, 59, 67, 76, 185, 193, 208-216; a glimpse of, 26, 27, 40, 52, 74, 76, 192, 193, 194, 196, 197, 198, 203; the snow-fields of, 40; the height of, 41, 42, 185; the base of, 42; the summit of, 74, 209; a splendid view of, 80, 192, 194; the geological formation of, 212; the possibility of climbing it, 214
Khonokhai pass, the, 274
— valley, the, 274
Khurgo valley, the, 168
Kirghiz tents, 11
— Ala-Tau, *vide* Terskei-Ala-Tau
Kish-talga, 135
Koi-kaf gorge, the, 227, 231, 233
— river, the, bed of, 235
— valley, the, 149, 150, 157, 227, 233, 234
Kok-belys pass, the, 120, 167
Kok-jar valley, the, geological exploration in, 185; the profile of, 240; the upper valley, 244
"Kok-kya range," the, 112, 135
Kok-rum river, the, 168, 169

Digitized by Google

Kok-rum valley, the, 144, 159, 165, 169, 172
Kok-shaal valley, the, 115, 122, 142, 169; traces of glacial action in, 117; aeolian corrosion in, 123
Kok-shaal-Tau, the, 116-118
Kok-su valley, the, 273
Kok-tan range, the, northern slope of, 107
Koneshar, 97, 136
Konganishuk-Yangyll Aul, 123
Kongul-jol valley, the, 62
Koshe-bashe Aul, 123
Kosh-karata valley, the, 144
Kostner, Franz, 6, 111
Krassnoff, A. M., expedition of, 3; the name given by him to the Tys-ashu valley, 64; his report on the valleys between Bedel and Kum-aryk, 144; crosses the Bedel pass, 170
Kuberganty, 185, 244
Kuchi oasis, the, 145, 158
Kukurtuk oasis, the, 140, 158, 168
— pass, 162, 164
— valley, the, 144, 158-165; the entrance to, 159; narrow gorges in, 162
Kulja, 275
Kulu-Tau highlands, the, 62, 238
Kum-aryk river, the, origin of, 149, 150; source of, 157, 175
— valley, the, 144-149, 150, 175, 233, 234, 235, 238
Kumbulung Aul, 124
Kungeu-Tau heights, 10
"Kuren," 97
Kurumduk river, the, 106, 108
— valley, the, 104
Kusgun-ya valleys, the, 62, 73, 194, 196
Kutingy, 15
Kuuluk-Tau heights, 10
Kyssalik, 135
Kysyl-gumbes, 118
Kysyl-kut pass, the, 152
Kysyl-tal valley, the, 135

LIKHANOFF, J. I., 12

MAI-BULAK valley, 62
Mai-tewe, 123
Mansur-tagh, the, 152
Maral-deer, 265
Maralty valley, the, 15, 17, 252
"Marble Wall," the, 28, 31, 33; its identity with Khan-Tengri, 41; the nucleus of the main ramifications of the Central Tian-Shan system, 211
Markesh-tagh, 116
Masar-Yakub, 128
Maurer, Herr, 111
Maydan-Gess valley, the, 104
Mikhailovich, the Grand Duke Nicholas, help afforded by, 2; reception accorded by, 7; his name given to the "Marble Wall," 211, 245, 251, 263, 269, 270; the author's indebtedness to, 280
Moro-khotan valley, the, 94
Mukur-mutu valleys, the, 14, 15, 247, 252, 262, 265
Munkys valley, the, 143, 144
Musart-daria, the, 135
Musart pass, the, 32, 82, 88
Musart rivers, the Great and Little, valleys of, 14, 15; valleys of the Great river, 263
— valley, the, entrance to, 82, 84, 269; length of, 85, 92; geological features of, 92; glaciation of, 94; lateral valleys of, 98; survey of, 270; entrance to the Little valley, 245, 246; exploration of, 245-253; view of the ranges skirting the Little valley, 256
Mushketoff, J. W., researches of,

Digitized by Google

1; tertiary sandstones found by him, 179
Mushketoff glacier, the, 41, 56, 57, 60, 189, 193; the chain skirting it, 41, 52, 190, 202; survey of, 189-192
— pass, the, 57, 191
Musulyk, 129, 132
Myn-dagyl-bulak valley, the, 144, 168
Myn-tyr pass, the, 240, 244
— valley, the, 185

Naryn river, 175, 178, 241
Narynkol, 12, 13, 14, 20, 79, 82, 185, 186, 246, 272
— pass, the, 80
— valley, the, 255
Nura-nor lake, the, 254

Oi-tattir oasis, the, 145, 146
Okhotnichi, *vide* Narynkol
Ot-bashi-tagh ridge, 124

Petroff glacier, 177
— peak, 138, 173; the position of, 143
Petrovsky, M. N. F., help afforded by, 112, 281
Pfann, Herr Hans, 193; joins the expedition, 3, 6; makes an excursion to the Alexander mountains, 8; surveys the Bayumkol valley, 29; determines heights of ranges in Central Tian-Shan, 42; his expedition on the Inylchek glacier, 73-75; completes his survey of the western glacier of the Bayumkol valley, 79; returns home, 102; his measurements of Khan-Tengri, 186
Photography, the use of, on the expedition, 17, 32, 40, 52, 56, 74, 119, 173, 177, 180, 186, 187, 188, 189, 194, 202, 209, 223, 245, 252 *et seq.*, 262, 263, 269, 272, 278
Pjevtzoff, M., 170
Pokhrovskaya, 183
Przhevalsk, 8, 183, 275
Przhevalski, M., 170

Russel, E., joins the expedition, 7; returns home, 102

Saravchy chain, the, 138, 145
— glacier, the, 149, 151-157; exploration of, 154; ascent of, 155; length of, 156
— river, the, 149, 153
— valley, the, 149, 152, 153; background of, 156
Safar-bai Aul, 122, 173
Saikal river, the, 254, and *vide* Musart, Little
— valley, the, 23, 245 *et seq.*; total length of, 252
Saizeff, Colonel, 281
San-tash pass, the, 10
Saposhnikoff, Prof., 8, 9
Sart-jol pass, the, 185
Sary-bel pass, the, 169
Sary-jass river, the, 38, 39, 40, 43, 44, 178, 186, 237, 238-241
— valley, the, 9, 36-59, 185 *et seq.*; present configuration of, 43; green prairies of, 61; waters of, 175, 178, 240, 241; the enclosing walls of, 239; breadth of, 241
Sary-jass-Tau, the, 238
Sary-jass-tuty, 13
Sary-turuk Aul, 122
Schubert, Herr, help afforded by, 8
Sella, Cavaliere Vittorio, help afforded by, 4, 281
Semenoff, P. P., 1, 2, 117, 280; discovers the significance of the glacial deposits in the Sary-jass valley, 43

Digitized by Google

Semenoff glacier, the, 9; excursions for the exploration of, 40, 186-188; the extent of the glacier, 43; the tongue of the glacier, 46; its breadth near the tongue, 47; its constancy, 48; its resemblance to European glaciers, 49; its length, 50; a survey of, 186-188
— pass, the, 50
— peak, the, 53
Serakh-su valley, the, 98
Severzoff, N. A., 1, 112
Shaikhle Aul, 147, 148, 157
Shateh pass, the, 275
Shinne Aul, 121
Shinne-davan pass, the, 121
Sindan river, the, 144
Slivkina, 183
Smirnoff, M., help afforded by, 275
Sogdan-Tau, the, 119, 121
Souka pass, the, 180, 181
— valley, the, 183
Steinmann, Prof., 4
Stoliczka, M., 104, 105, 107
Stubendorf, Lieutenant-General Von, 7, 281
Sugun river, the, 107, 108
— valley, the, 107
Sugun-karaul, 108
Sukhun, 130, 132
Sumba lamasery, the, 273
Sum-tash, 120
Syrt plateau, the, 177 *et seq.*, 218, 240

TAGH-TUMSHUK, 108, 124
Taldy-bulak, 10
Taltan-su valley, the, 144
Tamlok stream, the, 147
Tangitar ravine, the, 105, 106
— river, the, 106, 112
Tanke-sai valley, the, 144, 168
Tarim basin, the, 43, 139
Tashkent, report written in, 4; a journey to, 7, 109, 275
Tashmalik, 109
Tas-tepe cliff, 22
Taushkan-daria, the, 139, 144, 168, 169
Tegermen basin, the, 106
— lake, the, 105
Tekes plain, the, 14, 20, 81, 82, 246, 263, 273; tertiary formation of, 14
— river, the, 14, 20, 83
Temurlik passes, the, crossing, 274
Terek river, 128
— valley, the, 132, 133, 134, 152
Terek-ty river, the, 239
Terskei-Ala-Tau, the, 180, 181, 183
"Three Valleys," the, 226
Tian-Shan (Central), the, mountain chains of, 1, 19; higher regions of, 2; glaciers of, 3, 40; carbonaceous fossils in, 10; ice age of, 13, 22 *et seq.*, 34, 39 *et seq.*, 43, 63 *et seq.*, 81, 82, 86 *et seq.*, 94 *et seq.*, 117, 142, 149, 150 *et seq.*, 174, 178 *et seq.*, 218, 223, 226, 237, 246 *et seq.*, 255, 258 *et seq.*, 264 *et seq.*, 277; valleys of, 25; climate and snows, 29 *et seq.*, 54 *et seq.*; extreme heights of, 31; the glacier ranges of, 40; the southern base of, 139
Tilbichek valley, the, 128, 129, 130, 132
Togak Aul, 147
Tograk-Yailak valley, the, 96, 98
Tokai Aul, 147
Topadavan range, the, structure of, 99
Tosor pass, the, 181
Toyun valley, the, 103; Devonian fossils in, 104
Tur plateau, the, 76

Digitized by Google

Turpal-che valley, the, 96
Tute glen, 13, 14
Tutuk-tery valley, the, 135
Tyr-asha valley, the, 23
Tys-ashu district, the, hills in, 63
— pass, the, 65, 196, 236, 241, 243; coralliferous beds in, 243
Tys-ashu river, the, 62
— valleys, the, 62, 64, 76, 191, 193, 243
Tyukur-myt valley, the, 135

Uch, 121, 122
Uch-kul river, the, 239
Uch-Musduk, 120
Uch-shat, the, region, 226 *et seq.*
— river, the, 226, 228
Uch-shat-Tau, the, 226
Uch-Turfan, 125, 137, 139; views from, 138
Uechy valley, the, 180
Uertenty peaks, 17, 262
— valley, the, 15, 247, 251, 252, 267
Ui-bulak, 140, 144
Ukurchy, 275
Ukurchy streamlet, the, 22
Ulak-teke valley, the, 144
Ulluk-karkara valley, the, 185
Ulu-jailak valley, the, 144
Usun-gush mountain, 173
Uy-tal, 170

"White lake," the, 259
"White pass," the, 168

Yagus-tal valley, the, 135
Ya-konash valley, the, 134
Yak-tash river, the, 177-180
— valley, the, walls of, 179
Yakub Beg, 105, 116, 154, 162, 163
Yalin-Khanzyn glacier, the, 88
Yangi-Hissar, 109
Yar-jilga, 134
Yar-kasn-say valley, 260
Yashik-kul lake, 260
Yirtash river, the, 178, 239
Yulushu chain, the, 177

Zoological collection of the expedition, the, 279

Printed by Hazell, Watson & Viney, Ld., London and Aylesbury.

Digitized by Google

Digitized by Google

THIS BOOK IS DUE ON THE LAST DATE STAMPED BELOW

AN INITIAL FINE OF 25 CENTS
WILL BE ASSESSED FOR FAILURE TO RETURN THIS BOOK ON THE DATE DUE. THE PENALTY WILL INCREASE TO 50 CENTS ON THE FOURTH DAY AND TO $1.00 ON THE SEVENTH DAY OVERDUE.

DEC 13 1939
SEP 22 1941
MAR 6 1942
20
9Oct 1 5L U
20Apr'63
APR 2 1963
JUN 3 1999

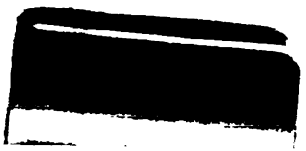
LD 21-100m-7,'39(402s)

Digitized by Google

YC 42110

M42035
D
E2M5

THE UNIVERSITY OF CALIFORNIA LIBRARY



Digitized by Google

THIS BOOK IS DUE ON THE LAST DATE STAMPED BELOW

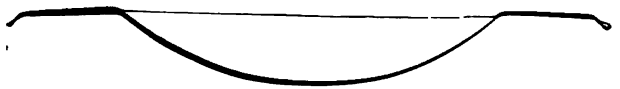
AN INITIAL FINE OF 25 CENTS
WILL BE ASSESSED FOR FAILURE TO RETURN THIS BOOK ON THE DATE DUE. THE PENALTY WILL INCREASE TO 50 CENTS ON THE FOURTH DAY AND TO $1.00 ON THE SEVENTH DAY OVERDUE.

DEC 13 1939
SEP 22 1941
MAR 6 1942
22 Oct 51
9 Oct 1 5LU
20Apr'63JC
RECD LD
APR 20 1963
JUN 30 1999

LD 21-100m-7,'39 (402s)

Digitized by Google

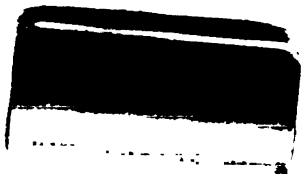
YC 42110



M42035

D[illegible]13
E2M5

THE UNIVERSITY OF CALIFORNIA LIBRARY



Digitized by Google